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The Canadian Engineer

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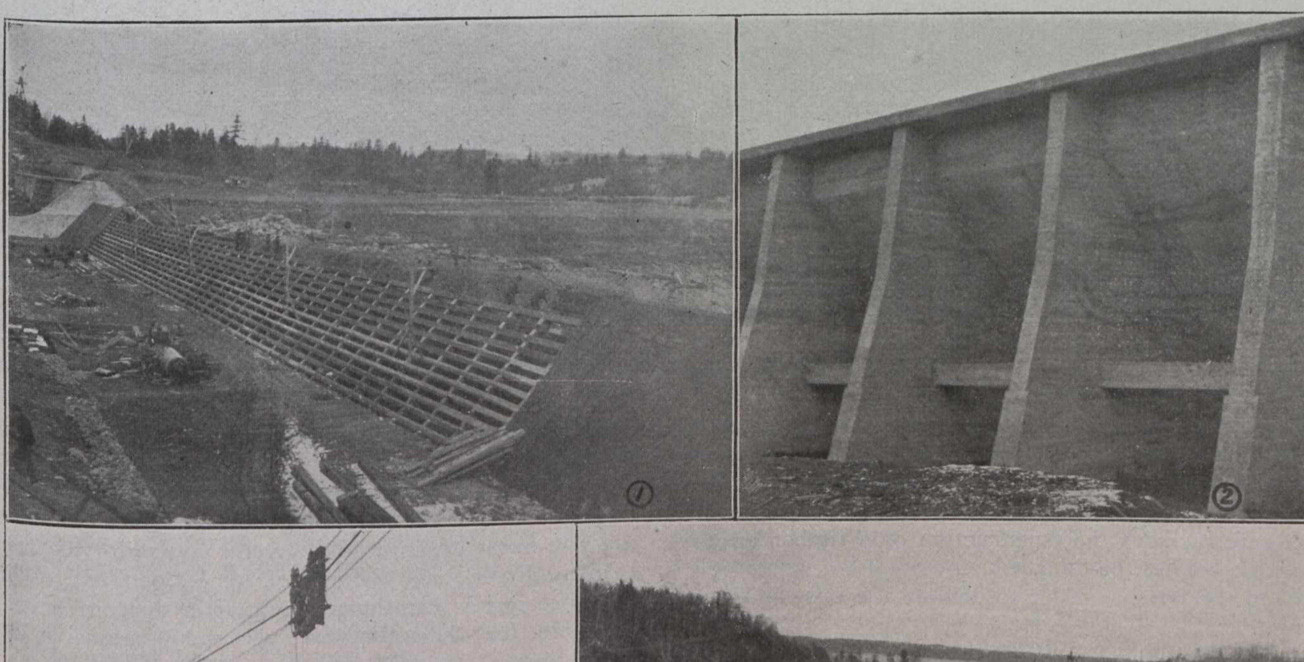
POWER PLANT AT DONNACONNA, QUEBEC

JACQUES CARTIER RIVER DEVELOPMENT FOR THE DONNACONNA PAPER COMPANY, LIMITED—NOTES ON THE DAM, INTAKE, PENSTOCK, POWER EQUIPMENT AND PAPER MAKING MACHINERY.

THE plant of the Donnaconna Paper Company, Limited, completed and placed in operation during the early part of last year, is situated on the Jacques Cartier River at Donnaconna, Quebec, thirty miles west of Quebec City, and directly on the main line of the Canadian Northern Quebec Railway.

The town of Donnaconna is scarcely more than a year old itself, having come into existence at the time of the construction of the plant. Its situation is ideal; located on the heights overlooking the St. Lawrence River, it commands an excellent view for many miles both up and down this great waterway.

The management of the company have seen to the welfare and comfort of their employees inasmuch as the town has already a modern electric lighting, water and sewage system. For the benefit of their unmarried employees and of the travelling public, they have also erected a fine modern hotel.



(1) View of Spillway from West Side. (2) Type of Abutment Construction, West Side. (3) Removing a 5-Ton Stone from Dam Site. (4) View of Dam, Spillway, Intake and New Course of Jacques Cartier River.

Surveys were made and work was started on the clearing of the site in November, 1912, but not until the spring of 1913 was actual construction commenced. Messrs. Eaton and Brownell, of Watertown, N.Y., were the engineers; the H. E. Talbott Company, of Montreal, Que., and Dayton, Ohio, were the contractors; whilst the whole work was under the direct supervision of Mr. G. M. McKee, general manager.

The dam is 1,112 feet in length, the buttress section, abutments, and intake being constructed of reinforced concrete, and the spillway section of British Columbia fir, with a concrete cut-off wall. It was the original intention of the owners and engineers to have constructed the whole structure of reinforced concrete, but owing to local topographical conditions the latter method of construction was finally decided upon. The river bed is composed of a loose stratified shale which disintegrates very rapidly on exposure to the very severe climatic conditions. In the timber spillway there was used 1,242,149 feet of timber which figure includes the construction of a timber apron 50 feet wide behind the dam, which carries the water well away from the base in order to obviate the possibility of scouring.

The penstock leads directly from the control house at the headworks to the power plant and is of steel—15 feet in diameter and 1,581 feet in length. For the greater part of the length the penstock is laid underground. The power plant is 225 feet by 27 feet and is equipped with five horizontal turbines of 1,200 h.p. each, four of which are directly connected to the grinders located in the grinder room adjoining, and one of which is directly connected to a 1,100-kw. alternating current generator which supplies current for the individual motors throughout the mill and for the lighting system of the town of Donnaconna.

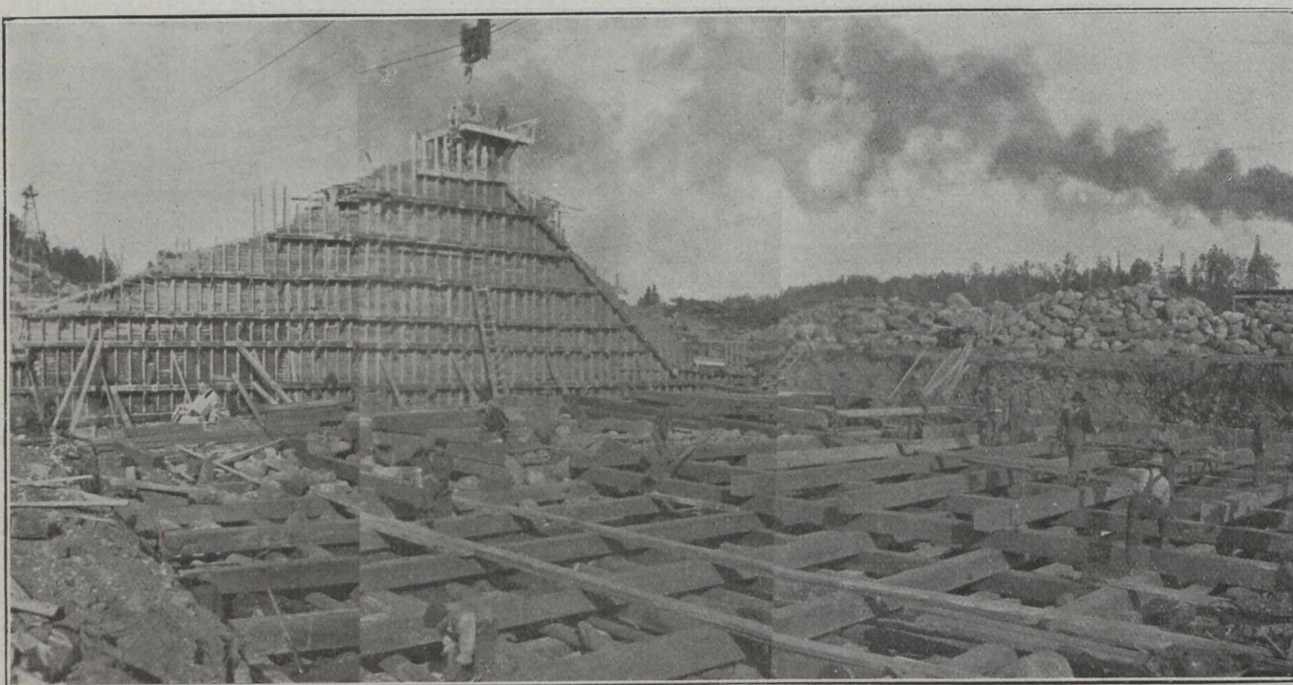
The grinder room is 125 feet by 50 feet, and is equipped with twelve Jenckes three-pocket grinders together with sliver screen apparatus. These grinders are coupled in sets of three on the main turbine shafts.

The groundwood wet room is 125 feet by 44 feet and is equipped with six horizontal centrifugal screens, manufactured by the P. P. Westbye Company, Hamilton, Ont., four wet machines and a battery of four pulp thickeners, the latter being manufactured by the Sherbrooke Machinery Company, Sherbrooke, Que.

The beater room is 64 feet by 56 feet, and is equipped with three 2,000 beaters and one Jordan beater engine.

The machine room is 52 feet by 273 feet, the paper machine itself being made by the Bagley and Sewall Company, Watertown, N.Y. The distance across the wire of this machine is 160 inches and at a speed of 600 feet per minute its output is rated at 50 tons per day.

For the purpose of supplying steam for the drying process there is a battery of three Babcock and Wilcox water tube boilers equipped with Murphy automatic stokers.



East Abutment and Dam, Under Construction.

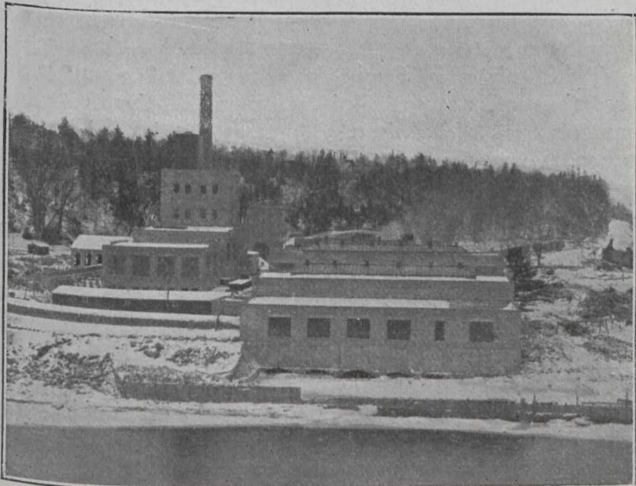
In order to carry out the construction of the headworks and spillway section of the dam it was found necessary to excavate an absolutely new course for the Jacques Cartier River for a distance of some 2,000 feet, owing to the previously mentioned shale river bottom being unsuitable for the otherwise necessary extensive cofferdamming.

During the excavation of this new river bottom, work was being prosecuted on the construction of the concrete section of the dam, which was completed before the water was diverted into the new channel. Closure openings were left in nine panels of the concrete section to take care of the water which had been diverted into the new river channel. Concrete was placed in this section by means of a Lidgerwood cableway operating a 1-cu. yd. bottom-dump bucket. The mixture used was in the proportion of 1 : 2 : 4 in the deck structure and 1 : 3 : 6 in the buttresses and end abutments.

On completion of this section of the dam the river was diverted into its new channel and a low cofferdam built up-river across the old bed at a point some 50 feet below the point of diversion. Work was then commenced on the excavation and the construction of the timber spillway, a fairly good idea of which is conveyed by the accompanying photograph.

Excavation for this was done by means of travelling derricks and the material being disposed of below the dam site. The concrete for the cut-off wall and the timber for the spillway were placed by means of the cableway. A 1-cu. yd. Smith mixer was used, to which materials were fed directly from storage bins, these bins being located on a spur line from the Canadian Northern Quebec Railway.

Simultaneous with the construction of the dam and headworks, work was being pushed on the laying of the penstock and the excavation necessary for the section to



View of Completed Mill Buildings.

be laid underground, also on the construction of the mill buildings and power plant. The whole work was completed and water was turned into the penstocks on the 15th of January, 1914, since which time the mill has been in practically continuous operation.

We are indebted to Mr. G. M. Williams, resident engineer for the contractors during the construction of the plant, for the foregoing information.

PUMPING WATER WITH COMPRESSED AIR.

An instance is on record where a 12 x 14¼ x 14-in. compressor furnished air for a mine pump 14 x 8 x 3 in. No other uses were made of the air and the air line was tight. Indicator cards were taken from both the air and steam cylinders of the compressor. The valve adjustments were good and the pistons tight. The total pumping head of the pump, including suction and pipe friction, was 103.1 ft. The water pumped was measured by a 4-in. orifice in a tank at the surface. The over-all efficiency from steam indicated horsepower to useful work done on the water was only 6.81%.

Pre-cast reinforced concrete pipe, 9 ft. internal diameter, 9 in. thick, 6 ft. long, are being used to line a 12-ft. brick tunnel of the Baltimore water supply system, and convert it into a pressure conduit for water at a pressure of 35 lbs. per sq. in.

In our issue of February 4th it was noted that a Montreal firm had in hand the construction of two large elevators at Manchester, Eng., for a firm of brewers. In addition this firm, the John S. Metcalf Company, is just finishing the Manchester Ship Canal Company's elevator No. 2, a concrete structure with a capacity of 1,500,000 bushels. Elevator No. 1, of like capacity, was built by the same firm several years ago.

CANADA'S MINERAL RESOURCES, AND THE PROBLEM OF THEIR CONSERVATION.

By Dr. Frank D. Adams,
Dean of the Faculty of Applied Science, McGill University, Montreal.

[NOTE.—A year ago the Commission of Conservation, Canada, appointed Dr. Adams Chairman of its Committee on Minerals, which for two years previous had been without an acting chairman. The following is from a report presented by Dr. Adams at the recent annual meeting of the Commission in Ottawa.—EDITOR.]

OUR mines rank third among our natural resources in the value of their output and second in the value of their exports. All these natural resources except the mines can, by intelligent care and conservation, be made to produce a much greater annual yield than at present, while at the same time showing a steady increase in value. These resources—agriculture, forests, fisheries and the fur trade—if properly managed, may be compared to money well invested. They can be made to yield an annual return in interest while the capital remains unimpaired, or even increases in value.

The mineral resources of a country, on the other hand, are in quite a different category—they are like a sum of money or treasure hidden in the ground. It does not renew itself, and every amount abstracted leaves just so much less for future use. When in a country of great extent like Canada the more accessible deposits become worked out, others are discovered in more remote portions of the national domain, and the output is thus maintained, or even increased for a series of years. The sum total of the mineral resources are, however, continually decreasing in direct proportion to the vigor with which they are exploited.

The earliest explorers to set foot in the Dominion expected to find in it a territory of abounding mineral wealth, and they were encouraged in this belief by tales which they heard from the Indians. The first mineral deposits which were made the basis of regular mining operations were the coal beds of Cape Breton, where serious work began in 1720, and the bog iron ore deposits of the St. Maurice district in the Province of Quebec, which were opened up by order of Louis XV. in 1733. As the country was opened up to settlement other mineral deposits were found and other mines developed. The value of the annual production in Canada, however, increased but very slowly in the earlier years. By the year 1886, when the Geological Survey of Canada collected and published the first statistics for which approximate accuracy may be claimed, the output had reached a value of somewhat over $10,000,000, of which about one-third was derived from the coal mines of Nova Scotia. Since that time the rise in production has been rapid, reaching a value of $144,000,000 in 1913. This rapid increase during the past 27 years is shown in the accompanying table.

In comparing the individual items making up the mineral output for the year 1913 with those of the year 1886, it is found that there has been an increase in the output of nearly every mineral substance mined in the Dominion. While the increase has been relatively greater in the group of the metals, it has also been enormous in the case of the non-metallic minerals, and especially structural minerals and clay products. The only mineral substances which were mined in larger amount in 1886 than in 1913 are antimony ore, chromite, manganese ore, baryta, molybdenite, petroleum and phosphates. The output of the first five mentioned of these substances in Canada was never very large, and gradually ceased, owing to the fact that the more easily accessible supplies of these raw materials became exhausted.

Year.	Value of Production.	Year.	Value of Production.
1886.........	$10,221,255	1900.........	$64,420,877
1887.........	10,321,331	1901.........	65,797,911
1888	12,518,894	1902.........	63,231,836
1889.........	14,013,113	1903.........	61,740,513
1890.........	10,753,353	1904.........	60,082,771
1891.........	18,976,616	1905.........	69,078,999
1892.........	16,623,415	1906.........	79,286,697
1893.........	20,035,082	1907.........	86,865,202
1894.........	19,931,158	1908.........	85,557,101
1895.........	20,505,917	1909.........	91,831,441
1896.........	22,474,256	1910.........	106,823,623
1897.........	28,485,023	1911.........	103,220,994
1898.........	38,412,431	1912.........	135,048,296
1899.........	49,234,005	1913.........	144,031,047

During the period under consideration some extensive and very valuable ore bodies have been discovered in the Dominion, among which may be mentioned the nickel ores of the Sudbury district and the silver ores of Cobalt. The former has now developed into the greatest nickel-producing area in the world, and is known to contain such enormous ore reserves that the present production can be continued for many years. The Cobalt district, on the other hand, while not discovered till 1903, developed almost immediately into the greatest silver camp in the world, but has already passed its period of maximum production, and, although it will for years to come still produce large amounts of this precious metal, is already in a state of decline. This is but repeating the experience of the older countries of the world, where what were once great mining regions have become completely exhausted. As instances, the Kongsberg Mines of Norway may be cited—which at one time produced great masses of native silver rivalling those now obtained from Cobalt; the lead mines of Great Britain, now completely abandoned; the renowned mines of the region of Freiberg in Saxony, worked continuously since 1170 A.D., the last of which is now about to be closed down, and the great diamond fields of the Golconda district in India, which no longer yield these precious gems.

In modern times it must be remembered that with the introduction of high explosives and modern machinery, the exhaustion of a mineral deposit is much more speedily attained than in former times, when only a relatively small tonnage could be raised annually from any mine.

The discovery and development of mining districts in any country, even although these must be exhausted in time, always attract population and yield wealth to a community in the early stages of its development, and are thus frequently of the utmost importance in bringing about the opening up and settlement of tracts of country whose inhabitants subsequently engage in other industries and find other means of support.

In Canada, however, our mineral deposits are of great extent and importance. Our coal resources, as shown by the investigations undertaken in connection with the meeting of the International Geological Congress which was held in Canada last year, are among the countries of the world, second only to those of the United States. The geological structure of the Dominion is furthermore such as to lead to the confident belief that as Northern Canada is made more accessible by the improvement of means of communication, thus facilitating exploration, large deposits of the metallic minerals will be found in the more remote portions of the Dominion, which, when opened up, will be important factors in the development of all the other latent resources of that great region, so that the mining industry of the Dominion, there is every reason to believe, will continue to grow and to play a very important part in the future history and development of the country.

While we cannot hope to increase our mineral resources by any process of conservation, it is of the greatest importance that, in working them, all waste should be avoided. The losses which have been sustained in other countries from lack of care and thought in this respect are enormous. Dr. Douglas estimates, for instance,—to take only one example—that at the Rio Tinto mines in Spain in a period of some thirty years, through an unskilful treatment of the ore, about 7,000,000 tons of sulphur, valued at not less than $70,000,000, were wasted while through modern improvements in the method of handling the ore about 1,000,000 tons of sulphur are annually saved to the world which would otherwise have been burned and served simply to pollute the atmosphere. The same writer points out that only some sixty per cent. of the hundreds of millions of dollars yielded by the Comstock lode was recovered at the time, and at first the enormously rich tailings were not even collected, such was the haste of the miners to empty that stupendous deposit which should have made Nevada prosperous for generations instead of whirling the whole country into a mad dance of reckless speculation.

The primary cause of a large part of the waste which has taken place in mining enterprises is over-capitalization. This necessitates a large output at any sacrifice if the dividends are to be paid on the whole amount. Over-capitalization thus demands over-production, which in its turn almost invariably involves waste at some stage of the progress of the metal from the mine to the consumer. On the other hand, a lack of sufficient capital to develop a mineral deposit in the proper manner has in more than one case in Canada led to serious waste, since in the endeavor to make the mine pay the cost of its own development as mining proceeded, only the richer ore was taken out, leaving the leaner portions of the deposit in positions which rendered subsequent extraction difficult or impossible.

It may be stated, however, that in Canada at the present time the waste which is incurred in working our deposits of metallic minerals is small. It is, as a general rule, to the miner's interest to extract his ore completely and to avoid waste. Certain losses take place in the concentration of ores by allowing values to pass away in the tailings. But in recent years the methods of concentration have been greatly improved and the tailings are much lower in grade than in former years. It it doubtful whether there is in Canada at the present time any considerable waste in the concentration of metallic ores which can well be avoided. Furthermore, where the tailings, as in certain places in the Cobalt district, while still containing in the agregate large amounts of metal, are too low in grade to permit of further extraction at the present time, they have been stored in such a way that if, in the future, it becomes possible to treat them again for the further extraction of their metallic contents, they will be readily available for that purpose.

THE OXYGEN CONTENT OF OPEN-HEARTH STEEL.

MUCH study has been devoted to the systematic examination of the oxygen content of commercial steels with a view to collecting trustworthy evidence as to the amount of oxygen to be expected normally in good class material, and the limits within which it is desirable to restrict this element. The following data are from a paper read last fall before the Iron and Steel Institute by Messrs. J. A. Pickard and F. M. Potter:—

All the steels examined had been made by either the acid or the basic open-hearth process, and, as far as could be judged from their analyses, they were generally of excellent quality. In the accompanying tables the samples are arranged in order of carbon content. The actual figures obtained for oxygen in duplicate analyses are given in the last two columns, and show the amount of agreement ordinarily obtained when using this method.

It had been expected from previous results that it might be possible to discover some relationship between the oxygen and the carbon content, but the results quoted lend but little support to this theory. One most important conclusion to be drawn is that it is possible to make all kinds of open-hearth steel, even low-carbon low-silicon basic (No. 9), practically free from oxygen—containing only 0.010 per cent. or under. That some steels are made containing more than that amount is, however, abundantly shown by the other results, and it is to be observed that the cheaper steels contain higher oxygen.

Acid open-hearth steel is generally admitted to be of better quality than basic open-hearth, and it has been suggested that this is due to the higher oxygen content in basic steel. In the tables all the high-oxygen steels (that is, over 0.020 per cent.) except one (No. 2) are found in the basic group, so that the evidence does support the conclusion that basic steel is higher in oxygen. It is to be noted, however, that only two of the basic steels are higher in carbon than the lowest of the acid group, and no marked difference is to be noted in those samples comparable in carbon content; indeed, No. 2, and acid steel, is higher in oxygen than Nos. 23, 25, and 26, which are basic.

An interesting question is raised by the fact that the samples that must have received most hot-working are all high in oxygen. Nos. 14 and 15 were taken from two fishplates, No. 22 from a rail, while the other samples were from fair-sized billets. The possibility that the oxygen content may vary after the steel has solidified has not hitherto been considered, so far as the authors are aware. It must be borne in mind, however, that these

Table I.—Acid Open-hearth Steel.

Sample.	Carbon, per cent.	Manganese, per cent.	Silicon, per cent.	Sulphur, per cent.	Phosphorus, per cent.	Oxygen, per cent. i.	Oxygen, per cent. ii.	
1	0.67	0.73	0.95	0.035	0.027	0.004	0.004	Mean—
2	0.79	0.65	0.210	0.030	0.050	0.020	0.021	Carbon, 0.87
3	0.93	0.68	0.035	0.031	0.027	0.007	0.006	Oxygen, 0.011
4	1.08	0.62	0.024	0.033	0.022	0.012	0.016	Mean—
5	1.18	0.65	0.056	0.027	0.025	0.005	0.006	Carbon, 1.35
6	1.33	0.42	0.140	0.030	0.024	0.004	0.007	Oxygen, 0.007
7	1.55	0.49	0.100	0.027	0.026	0.010	0.012	Mean of all—
								Oxygen, 0.0096

Table II.—Basic Open-hearth Steel.

Sample.	Carbon, per cent.	Manganese, per cent.	Silicon, per cent.	Sulphur, per cent.	Phosphorus, per cent.	Oxygen, per cent. i.	Oxygen, per cent. ii.	
8	0.10	....	.....	.....	.....	0.038	0.036	
9	0.14	0.35	0.020	0.033	0.018	0.010	0.011	
10	0.20	....	.....	.....	.....	0.031	0.028	
11	0.23	0.70	.....	0.060	0.026	0.013	0.014	Mean—
12	0.26	0.49	0.120	0.030	0.031	0.003	0.006	Carbon, 0.25
13	0.30	....	.....	.....	.....	0.030	0.027	Oxygen, 0.021
14	0.32	0.62	.....	0.051	0.020	0.040	0.041	
15	0.33	0.62	.....	0.057	0.025	0.024	0.021	
16	0.35	0.56	0.182	0.027	0.020	0.005	0.008	
17	0.41	0.52	0.026	0.032	0.023	0.019	0.014	
18	0.44	....	.....	.....	.....	0.029	0.025	
19	0.54	0.69	0.085	0.022	0.024	0.003	0.003	Mean—
20	0.55	0.97	.....	0.055	0.011	0.016	0.017	Carbon, 0.52
21	0.55	....	.....	.....	.....	0.020	0.020	Oxygen, 0.021
22	0.61	0.74	.....	0.053	0.021	0.038	0.044	Mean—
23	0.66	0.65	0.100	0.033	0.052	0.005	0.006	Carbon, 0.81
24	0.75	0.38	0.025	0.025	0.022	0.025	0.026	Oxygen, 0.011
25	0.82	0.67	0.096	0.030	0.028	0.004	0.007	Mean of all—
26	1.00	0.67	0.036	0.016	0.025	0.006	0.007	Oxygen, 0.0189

steels, as judged from their other constituents, were not of the very highest quality, and that Nos. 8, 10, 13, 18, and 21, which are all high in oxygen, were of cheap make.

The results obtained by previous workers are very scanty. The authors, in their preliminary investigation, found only the figures given by Cubillo, who gave for acid open-hearth steel in the ladle, 0.004 per cent. of oxygen; and R. H. McMillen, who has published the following percentage data:—

Sample.	C.	Mn.	Si.	S.	P.	O.	
Basic O.H.	0.07	0.06	0.08	0.019	0.008	0.113	0.115
Basic O.H.	0.08	0.22	0.01	0.016	0.008	0.079	0.072
Basic O.H.	0.36	0.69	0.03	0.040	0.046	0.043	0.042

The method of reduction in a current of hydrogen, used by both workers, is, according to the authors, open to several objections. Mr. McMillen's figures are very much higher than those found for any steel examined by the authors. Taking this in conjunction with the fact that no steel examined by McMillen gave a lower value than 0.035 per cent.—even crucible steels, containing 1.17 per cent. and 1.14 per cent. of carbon, showing 0.035 per cent. and 0.045 per cent. respectively of oxygen—the authors are inclined to think that he must have been the victim of a systematic error not recognized.

A necessary and important consequence of low-oxygen content, if the determination of oxygen be made by the method used, is that the gas content must also be very low, at least in respect of carbon monoxide and dioxide. It was shown in the paper already mentioned that the oxides of carbon are reduced to water under the conditions of the experiment; consequently carbon monoxide and carbon dioxide contained in the steel, or given off from it on heating, are reduced and their oxygen appears in the final result.

If a steel gives off its own volume of carbon monoxide on heating, the oxygen in the gas represents an amount equal to 0.0091 per cent., a similar amount of carbon dioxide representing 0.0182 per cent. This conclusion is not invalidated by the fact that the steel is used in the form of fine turnings, as, although gas may be lost during the operation, the oxides of carbon are invariably practically absent from the gases obtained, which consist of nitrogen and hydrogen.

THE ELECTRICAL INDUSTRY IN ITALY.

From statistics recently published, brought up to the end of March, 1914, it appears that the Italian companies concerned in the production and distribution of electricity number 151, having 302 stations at work, with a production equal to 763,000 h.p., while nine stations are under construction, with a capacity of 125,000 h.p. The capital employed by these companies amounts to $90,600,000. Firms engaged in the output of electrical machinery number 16, employing power to the extent of 3,310 h.p., and with a capital of $7,200,000.

The amount of polish which can be given to the surface of concrete depends upon the density of the mixture and the nature of the aggregate used. After the surface has been smoothed down on a rubbing bed, or by the use of rotary rubbing stones, as applied in terrazzo floor work, the procedure is somewhat similar to that used in polishing granite or marble. The aggregate exposed on the surface by the rubbing process takes the polish, the appearance of the surface being dependent upon the percentage of aggregate exposed.

DEMAND FOR RAILWAY MATERIALS IN ARGENTINA.

Argentina, like Canada, is a country of vast distances and large grain areas, and the transportation problems of the two countries, to develop full resources, resemble each other. The demand for railway material in Argentina has been large in the past, and is destined to be the same in the future. In so far as Canadian manufacturers are concerned in this market, the Department of Trade and Commerce reports that all orders for the British-owned roads go to head offices in London. This method of procedure is followed, not only in such articles as rolling stock, rails, accessories, etc., but also in those commodities which make up the stores of every well organized railway company. In the latter would be included such articles as picks, spades and shovels, wheelbarrows, track tools, furniture, electrical material, paint, etc., etc. One of the few articles purchased locally is calcium carbide. Such being the case, it is patent that any Canadian manufacturers of locomotives, passenger and freight cars, should, as a preliminary to competing for this business, have a capable representative in London, or as an alternative they must appoint agents of standing. Probably the control of the situation is in the hands of the consulting engineers of the various systems, and it is with them that connections have to be formed. Some months ago some of the London offices of the British-owned railways expressed themselves as being very willing to assist Canadian industrial enterprise, where it could be shown that Canadians were able to compete with British, American and continental makers, in price and quality, and also to purchase in Canada when their requirements could not be filled in the United Kingdom.

Now that Belgium, France and Germany are likely to be out of the running for a number of years, it would seem that Canadian factories may have an opportunity to compete on terms considerably more favorable than could have been expected a few months back. Large orders are unlikely to be placed for a year or two, but it is reasonably certain that before the Continental countries mentioned above can recover from the effects of the present war, whenever it may end, much stock now in use will be worn out, and will have to be replaced if the railways are to be maintained in a high state of efficiency. But whether orders be placed within the next six months, or within the next two years, the present is the time to commence preparing for the business.

It must be borne in mind that Argentina has a railway mileage of nearly 21,000 miles, of which 15,700 belong to British-owned roads; that she produces more grain of various kinds than does the Dominion, and she has a larger foreign trade. Like Canada, her railway requirements are never ceasing. Circumstances being as they are, it is safe to say that Canadian manufacturers of rolling stock are likely to find openings within the next two years that will give them more than a fair chance to secure a footing in South America.

Advices to the Hon. Thomas Taylor, Minister of Railways, are to the effect that the concrete piers of the Kettle Valley Railway bridge across the Tulameen River at Princeton are complete and are now ready for the wooden Howe truss superstructure. Promise is made by Vice-President Bury, of the C.P.R., that the line will be open to traffic to Nelson by June 1.

THE FLOW OF SANDS THROUGH ORIFICES.

It is somewhat surprising that more data is not available respecting the flow of dry sands and like substances through orifices under varied conditions and different heads. Doubtless a study of the subject would result in some useful information. It would be desirable to know, for instance, (1) the rate of flow of dry sands and other substances under definite conditions; (2) the extent of the variation in flow under varying conditions; (3) the influence of the physical qualities of the substance, and (4) the form and size of required discharge-orifices to permit of unfailing flow or other desired results.

This has been a subject of investigation by Mr. Ernest A. Hersam, associate professor of metallurgy in the University of California. Mr. Hersam used three forms of appliance for measuring the flow: (1) with discharge-orifices of ½ inch or less in diam.; another with orifices greater than ½ inch diam., and a third of special design, used in certain small tests of limited application. A description of his work, appliances used, methods of accurate measurement, results acquired, and conclusions arrived at, form the basis of a paper presented last year to the Franklin Institute. The results of the tests are exceedingly interesting, but of considerable length, and we present only the deductions arrived at by Mr. Hersam at the close of his investigation:—

Conclusions.—The uniformity of flow of sands through discharge-orifices is influenced by the dampness, fineness, and general quality of the material. The momentary irregularity of flow is perceptible to the eye in the case of orifices that are small relative to the coarseness of the material. With long periods of observation, in the case either of large or of small orifices, a smaller but persistent variability is found to exist which is not materially diminished by greatly prolonging the time. The deviations from a uniform flow draw the attention to the manner of supplying the material to the orifice, the compacting, the head, the shape and size of the supplying receptacle, and the time during which the material is permitted to remain at rest before the flow begins. Uniformity is greatest in the case of substances least compacting under pressure, and under conditions of flow that loosen the material above and near the orifice. It is favored by thorough dryness, rounded particles, and a low sand-head. Observations deviate less than one part in six hundred in the case of river sand of .01 inch diameter, under a sand-head of three inches, flowing five minutes through round orifices of ¼ inch diameter; while under the same conditions, but with angular or damp material, deviations exceed one part in fifty.

The velocity of flow under the existing conditions of gravity is governed chiefly by the size of the orifice and the size of the grains. Other important influences are the shape and surface condition of the grains and the shape of the orifice. Other conditions to be mentioned exert a less marked influence.

The size of the grains influences the velocity of flow, causing, with the increase in size, a decrease in the velocity. There was observed in river sand a maximum velocity at which the ratio of the diameter of the grains to that of the orifice ranged from 1:15 to 1:30 approximately. With finer material the velocity quickly dropped from this maximum, while with coarser the drop was seen to be gradual, and, on the whole, more regular. The size of the grains is closely related to the shape and surface condition, one quality merging into another and requiring common consideration in the case of substances which require handling in practice.

The moisture content produces a retardation of the flow. The influence with increasing fineness and decreasing density becomes greater. The moisture in material which is positively dampened can alter the rate of flow many-fold, producing results out of all semblance to uniformity. As the material becomes progressively drier, the velocity of flow becomes greater and more uniform.

Angularity of the particles causes a diminution of velocity. The effect is less marked with fine material and with large orifices.

The uniformity of size of the grains is of influence upon the velocity. The velocity of a mixture of materials, with respect to the weight, approximates and slightly exceeds the mean of the velocities of the two sizes flowing separately. Thus the time occupied in the discharge of a given weight of material of mixed sizes is slightly less than that which would be required for the discharge of each sized constituent separately.

The material of which the orifice is constructed is shown to modify the velocity to a small extent.

The specific gravity of the flowing material is without relatively appreciable influence upon the velocity of flow under practical conditions.

The sandhead exerts a barely appreciable influence upon the velocity of flow. The influence is in the direction of a decreasing velocity with increasing head. With materials capable of becoming compressed or compacted, the retarding effect of the head becomes more pronounced. A consideration of the sand-head must thus include not only the height of the column and the specific gravity of the material, but the impact in gathering above the orifice, the dampness, coherence, and the angularity.

The contour at the surface of the material above the orifice exerts a minute influence upon the velocity. Thus when the surface is allowed to sink directly above the orifice, so as to form a pit, there is a slight increase in flow perceptible beyond that observed when the surface is level at the height corresponding to the bottom of the pit.

The shape of the receptacle supplying an orifice has but slight influence upon the velocity of flow where the bottom is flat around the orifice and the vertical column of material above the orifice remains unobstructed.

The effect of taper in orifices is an increase in flow where the enlarged opening of the orifice is presented to the descending material.

The length of discharge-orifices, or the thickness of the plate through which orifices are cut, is of scarcely appreciable effect as examined within the range of one inch.

The size of an orifice at the minimum required for an assured continuous flow must liberally exceed that found suitable for short intervals, to provide for the variability in quality of usual sands and the chance arrangement of particles in obstruction. The diameter of round orifices suitable for the steady flow of the sand materials tested ranges from five to twenty times the diameter of the particles, according with the size and quality of the material.

The horizontal, cross-sectional shape of the vertically discharging orifice influences the velocity of flow. The velocity is highest among the discharge-orifices tested having the greater ratio of area to periphery.

The area or size of the orifice affects the velocity. Thus the discharge is governed both by the area over which the given velocity is effective and by the velocity resulting from this area. The velocity decreases with the decreasing diameter of the orifice, the curve showing a rapid decline near the limiting size of the orifice where the flow becomes irregular.

The differences in the surface condition of the grains, with the influence which this has upon the cohesion and the frictional coefficient, produce an important effect upon the velocity of flow. The content in moisture, the composition of the material, the hygroscopic properties, the angularity, and the uniformity of size are best judged, for purposes in practice, by the evident general quality of the material as a whole. In the case of lead shot, a material in which the influence of angularity of the grains is eliminated, a variation of 20 per cent. or more in the velocity results from the alteration of the surface with substances imparting a high and a low coefficient of friction.

An approximate constant to express the flow in terms of the orifice area, or the coarseness of material, can be used to gain a general idea of the discharge capacity of an orifice for a given material. Under the conditions of apportionment of sand materials by orifices in practice, prediction must be considered widely approximate. Results, moreover, are liable to marked deviation from changing quality of the material. In such application, differences in the specific gravity and the sand-head are of relatively small importance. The flow is seen to be actuated by the force acting upon the material distant but few diameters of the orifice from the orifice, and is thus affected only by the condition there existing. There is little serviceable analogy between the flow of fluid substances and of sand composed of solid grains.

An expression giving an idea of the flow to be expected would be sought for certain purposes from the trend of the curves. For such approximation, in which an accuracy of some 20 to 50 per cent. is obtained, based upon the size of the round orifice and the coarseness of the material, the following formula may be suggested:—

$$V = k \frac{d - cm}{\sqrt{d}}.$$

Here d is the diameter of the orifice in inches, m is the diameter of the particles in inches, V is the velocity of flow in feet per second, and k and c are constants to which are assigned respectively, in approximation, the numerical values 1 and 2.

The weight of sand discharged during each minute is correspondingly shown in the same degree of approximation by substituting the above value of V for the value v in the equation for round orifices, deriving the following equation:—

$$W = 20.43\, s \sqrt{d^3}\, (d - 2m).$$

Here W is the weight of sand discharged in avoirdupois pounds per minute, s is the specific gravity of the sand in the dry, loosely aggregated state, d is the diameter of the round orifice in inches, and m the diameter of the grains in inches.

An outline of the conclusions to be drawn from the tests described would be: (1) The increase in the velocity of flow with the increase in the diameter of the orifice; (2) the increase in the velocity of flow with the decrease in the diameter of the particles until the size of relatively fine material is reached; (3) the comparative unimportance of the variation in specific gravity of materials; (4) the relatively small influence of the variations in head; (5) the relatively small influence of the shape of the supplying reservoir; and (6) the influence of dampness and compacting qualities of the material, most marked in the fine sizes.

APPLICATION OF CONCRETE IN MODERN SANITATION.

CONCRETE has played its part in sanitation for many years with more or less success, according to the skill of the designer and the quality of the materials and workmanship. The tendency in recent years has been to employ concrete more and more, and this tendency in the future is sure to extend its use in directions where now it is scarcely applied. Its application to sanitation works in England was reviewed lately in a paper presented by Mr. Henry J. Tingle, M.Inst.C.E., to The Concrete Institute. The speaker traced the history of its adoption, its reception by the Local Government Board, and forecasted a very extensive use in future works. The following is a brief summary of his paper:—

Concrete has been, and is now, extensively used in the construction of reservoirs, sewage tanks, filters, aqueducts, and water towers. Full descriptions of these works are to be found in technical journals and volumes of proceedings of the various engineering societies. The same holds good for similar structures in reinforced concrete, though to a more limited extent.

Mass concrete has been largely used in the construction of sewers of 4 ft. diameter and upwards. It is moulded in the trench and supported by centering until set. Elliptical sewers are also constructed in this manner. In recent years reinforced concrete has been employed for sewers of both types, the mixture being sufficiently stiff to admit of ramming.

Concrete pipe has been extensively employed in main sewerage work in England for many years past, being supplied ready for use by firms who have taken up its manufacture. Such pipe, unless strongly reinforced, should be laid on a concrete bed not less than 6 in. in thickness, and the concrete brought up around the pipe as far as the springing. By the omission of this precaution failures have occurred. In pipes liable to internal pressure the concrete should entirely surround them.

These pipes often have ogee, rebated joints which are lined with cement and the inside pointed up.

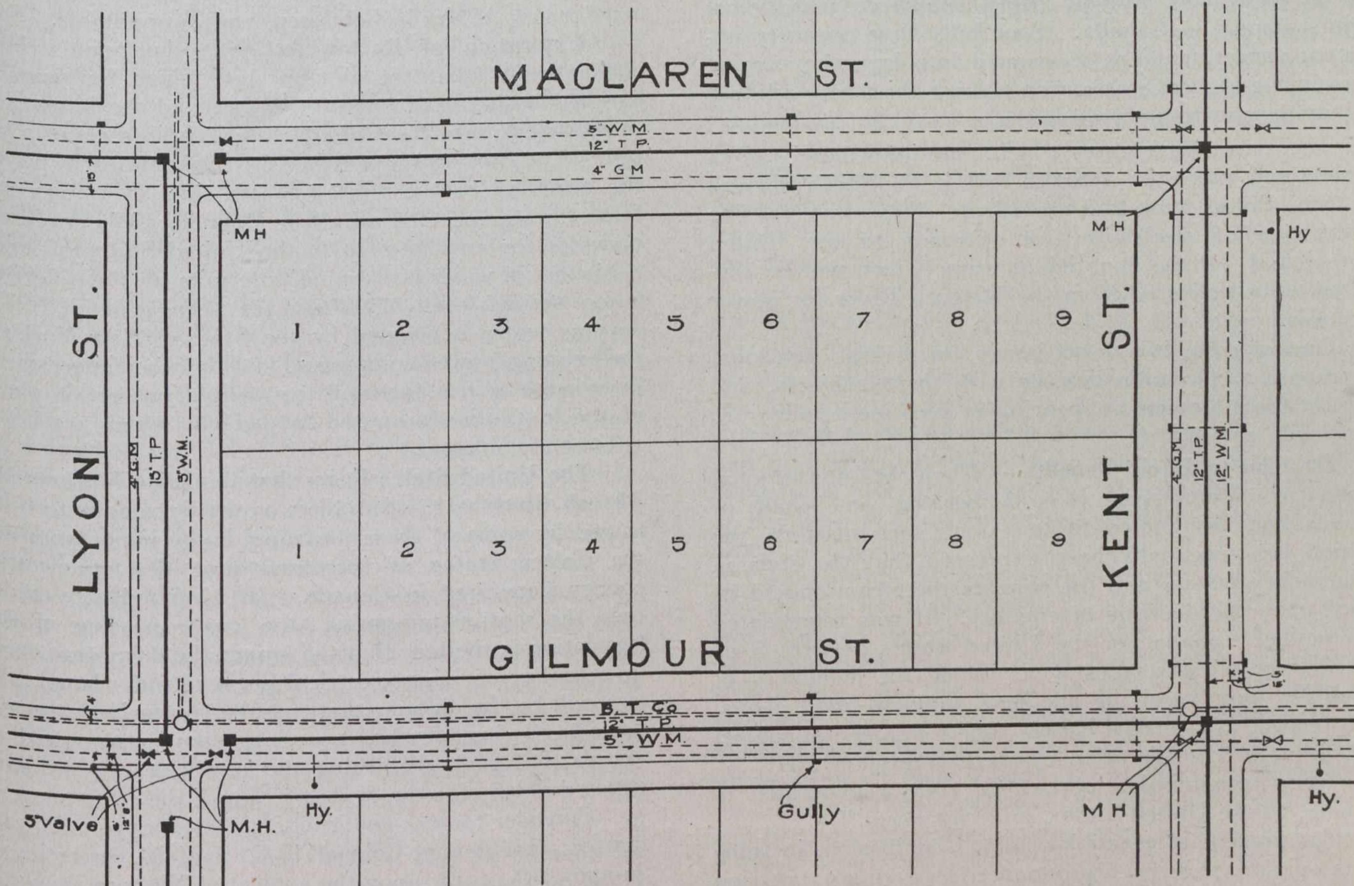
Reinforced concrete pipes have been used for water mains at Swansea against heads of 246 ft. and 500 ft., at Norwich for sewage rising main head 131 ft., and at Clydebank for water head 390 ft., and are about to be laid at Leeds for water. They have been largely used on the continent and 119 miles of 10-in. to 49-in. water mains were in course of construction in Flanders at the outbreak of the war. They have also been largely used in Paris. Twenty years since, the municipality laid down one mile of 6-ft. diameter as a rising main for sewage head 115 ft., in a gallery alongside a steel riveted main of same diameter. It has been found that the steel main requires considerable maintenance, and the concrete tube none. Concrete pipes are constructed to form manholes, water tanks and cesspits. Sewers, reservoirs, manholes, etc., are constructed with moulded blocks of concrete which are supplied by various manufacturers.

As illustrating in greater detail the application of concrete to sanitation works the author described and illustrated the following examples: Failure and reconstruction of concrete-covered reservoir; temperature cracks in concrete reservoir wall; ejecter chamber in concrete with steel-plate lining; concrete mole forming sewage outfall into sea; circular hydrolytic tanks in reinforced concrete.

UNDERGROUND SURVEY OF OTTAWA.

By L. McLaren Hunter, A.M.Inst.Mun. and Cy.Eng.
City Engineer's Department, Ottawa.

SEVERAL times during the past few years when experts have been called in to co-operate with the city engineer of Ottawa on various large engineering projects, great difficulty was encountered in supplying them with very necessary information, such as the site of water mains, sewers, location of valves, manholes, hydrants, etc. Thus it became an absolute necessity to have an underground survey of the city commenced.



Typical Section of Record Plans.

Last year a gang of men were started to open up streets where sewers and other underground pipes or conduits had been laid without any record having been kept, and a survey was made showing the location of the mains found and their depth. This work of locating mains was also carried out when a street was having surface drainage put in preparatory to a pavement being laid, the measurements being all taken from the sidewalks. The survey is now so far ahead that a start can be made to have it placed on paper.

As no special appropriation has been made to carry this undertaking through, work on the scheme has been to date proceeded with very cautiously, the expense being borne by the general account.

Particular attention will be given to the location of water mains and sewers, as this year Ottawa will embark on a scheme for the redistribution of water mains which will cost when completed about a million dollars—$420,000 having been voted on January 4th to start the work. A new sewerage scheme for the city will also possibly have to be undertaken within the next five years, which will involve an enormous outlay of money.

The survey will be plotted to a scale of 40 ft. to the inch. This is the same scale as that of the pavement plans, so that it will not be necessary to re-survey the streets possessing permanent pavements. The record plans will be 30 x 24 in. in size. All underground work will be shown on the plan in broken lines, excepting the sewers which will be denoted by extra heavy solid lines. All surface delineations will be made in light solid lines. There will be shown on the plans the location of all manholes, valves and hydrants, and also the gutter grates on paved streets.

The elevation of the sewers will be marked at each manhole and for the balance of the underground work the depth below sidewalks will be shown.

HEAD OF STEEL AT McLENNAN.

The head of steel on the Edmonton, Dunvegan and British Columbia railway has reached the second divisional point of McLennan, formerly known as Round Lake, thus completing track-laying for a distance of 262 miles from Edmonton. Trains, both passenger and freight, at present are running to mile 235, at High Prairie, and although the track is not ballasted onwards from Smith, the first divisional point at mile 131, a splendid and regular service is being maintained.

Water Commissioner Rust, Victoria, B.C., who recently visited Humpback reservoir, reports that the maximum amount that can be stored, over 130,000,000 gallons of water, has been poured into the reservoir, which will be shortly used by the city.

THE NIAGARA POWER SITUATION.*

By Arthur V. White, M.E.,
Consulting Engineer, Toronto.

A COMPLEX situation exists along the Niagara River, more particularly in the vicinity of the Falls. Since the ratification of the Boundary Waters Treaty, a number of bills, relating to hydro-electric development on the Niagara River, have been presented to the United States Congress. Two such bills have been under special consideration by the Committee on Foreign Affairs. Of the various bills introduced, the provisions of these two are the more important, and if enacted into law, without being modified, will be of serious import to Canada. Such bills have one very important aspect, namely, if enacted into law, they are of force in the United States even though the treaty relating to boundary waters should lapse.

There are two features which more immediately affect Canada and which are common both in the Smith Bill and the Cline Bill as these bills are called. These are: (1) The exportation of electricity from Canada to the United States; and, (2) the quantity of water which will be permitted to be delivered from the Niagara River for power purposes.

During 1914, it was necessary, on several occasions, to prepare memoranda dealing with these subjects, and some of the statements appearing in such memoranda are here made use of.

Doctrine of Equal Benefits.—When the International Waterways Commission has deliberated on behalf of Canada and the United States, upon such matters, the opinion has repeatedly been expressed that the division of boundary waters and the benefits therefrom should be based upon the doctrine of equality. It was represented that neither Canada nor the United States desired to be forced into circumstances which made for inequality of benefits without receiving adequate *quid pro quo*. Thus, with respect to electrical energy, one fundamental subject laid down for consideration by the Commission was:

"The transmission of electric energy generated in Canada, to the United States, and *vice versa*."

The present International Joint Commission, in some of its opinions, has been pronounced in giving expression to this same principle, or doctrine, of equal rights and benefits.

A Question of Jurisdiction.—One other point involves the question of extent of the jurisdiction of the International Joint Commission, with respect to certain diversions of water above the Falls. Both the Smith and the Cline Bills contain provisions which imply a raising of this question.

A careful reading of the Boundary Waters Treaty will show that the International Joint Commission have jurisdiction over the Lower Niagara River. It would, however, appear that the authors of the Bills, above referred to, as well as certain other persons, assume that the Commission are without jurisdiction for certain diversions above the Falls.

The Subject of Plant Efficiency.—This subject of jurisdiction may involve the right to utilize the additional 100 feet of head existent in the Lower Niagara River. And in this connection both the Smith Bill and the Cline Bill contain provisions relating to efficiency of plants; and to the possible enforced abandonment, at the order of the Secretary of War, of the present power developments at Niagara Falls on the United States side of the boundary, and the replacement of these plants by others utilizing the water under the combined head obtainable from the Falls, and the rapids of the lower river. This is an important subject, because, for one thing, companies in the United States—notably the Niagara Gorge Railway Company—appear to be seeking an opportunity to make diversions from the Lower Niagara River. It would be profitable to consider to what extent either of the bills would afford opportunity for companies to secure such rights of diversion and, in this connection, the remarks of the late Secretary of War, before the Committee on Foreign Affairs in February, 1913, are notable.

Expiration of Burton Act.—Another point to be remembered is that the Burton Act, which for years restricted both the diversion of water and the importation of electricity into the United States, expired about a year ago. The Burton Act provided for the granting of permits for diversion on the United States side, of 15,600 cubic feet of water per second. The Boundary Waters Treaty provides for an allotment to the United States of 20,000 cubic feet of water per second. Permits for the difference, 4,400 second-feet, have not yet been granted. This surplus water is coveted by the State of New York; by the existing power companies, and by other interests. A knowledge of this fact will throw light on certain phases of the legislation proposed in the bills which are here a subject of comment.

The United States Fears that Canadian Markets May Absorb Electricity.—An object avowedly sought to be attained by some of these measures is the importation into the United States of increased quantities of electrical energy generated in Canada. It is abundantly evident that the motive prompting the early passing of such legislation is the fear that the longer the delay that occurs in actually receiving electrical energy from Canada, the less will be the amount that may be so received; because Canada, owing to her growing manufactures and demands, is rapidly absorbing the surplus energy which is coveted chiefly for the State of New York.

Consider some confirmatory testimony upon this matter: Lieutenant-Colonel J. C. Sanford, reporting on January 6th, 1913, upon the subject of Niagara Power, to the Chief of Engineers, United States Army, states:

"There is no question but that Niagara power will soon be utilized to the fullest extent allowed by governmental restrictions. If advantage of the power, generated in Canada, cannot be had on the American side, manufacturers will be attracted to Canada by this cheap power, and the industries of this country will suffer accordingly. The effect of present restrictions on the importation of power is becoming noticeable. . . . Manufacturers at present contracting for additional Niagara power must locate, and are locating, in Canada. It therefore seems advisable to permit immediately the importation of Niagara power to the fullest extent permissible under the law, and, other things being equal, to grant permission for its importation to the company or companies which will make the earliest use of such power."

The former Secretary of War, Hon. H. L. Stimson, before the Committee on Foreign Affairs, recently stated:

"The investigation which has been made by the engineers indicates that Canada, if we do not take it, will use the entire amount that the treaty permits in a very short time, so that whatever effect any restrictions on importation would have, would not protect the Falls for

*From a report to the Commission of Conservation, Canada. Annual Meeting, Ottawa, January, 1915.

more than a very brief period, and it would result in giving to Canada, very possibly, a large number of industries which otherwise would be established on this side of the Falls."

When Representative Chas. B. Smith was speaking on behalf of his bill, he submitted, before the Committee on Foreign Affairs, a letter from a leading citizen of Buffalo, in which it is stated:

"Every restriction on the importation of Canadian power should be at once removed. Electrical power is a raw material and should be free."

The sub-committee on Niagara Falls power, appointed by the Committee on Foreign Affairs, in their report on one of the Cline Bills, state that it had been urged for their attention "that the Canadian companies were rapidly increasing their sales and would very soon take the full amount of water they were entitled to and the United States ought to get what power it was able to now." And they add: "If the advancement in the development of power on the Canadian side increases for another year or so—and it is not apparent to the committee that it will not—then the committee concluded that it was proper to take as large an amount as it could get for consumption in the villages, cities, factories and homes along our border."

Representative Chas. B. Smith, of the State of New York, in conversation, stated to the writer that he favored no restriction on the importation of electricity, because if it was good for United States to have this commodity he thought it was advisable to get as much as possible, and permit it to come into the country without any restriction. This view of Mr. Smith is amply reflected in certain bills of his which provide for no restriction.

Market in United States for Electricity.—In the State of New York there is a ready market for additional electrical energy. The opinion, delivered on February 12th, 1914, by the Public Service Commission of the State of New York, states: "That there is a large shortage of electric power in Western New York with a strong demand for greater supply which is not being met by existing companies." Again the opinion states: "We are using all the power made on the New York side, and all that has been brought from Canada, and the demand for more power in Western New York is insistent and being urged with great force."

It is also stated that Niagara Falls power produced in the United States is so far from supplying the needs of portions of the State of New York that, if the importation of power were prohibited, it "would plainly amount to a great public calamity."

It is most definitely affirmed that there is present demand for additional electrical energy on the United States side of the boundary, and, in consequence of this market, strenuous efforts, especially during the last two years, have been made to secure as large an amount of power as possible from the Canadian side. By so doing, vested interests may be created, and thus make it difficult, if not impossible, for Canada ever to use this power without the risk of serious international differences.

International Complications Possible. — Canada, naturally, desires to avoid contributing to any circumstances which might have within them the possibility, later, of creating difficulty with any foreign nation, and especially any difficulty with the Republic on her southern border.

The chief danger lies, not with the peoples themselves, but with the aggressiveness of powerful United States commercial interests whenever they fear their assets are jeopardized.

In the opinion just rendered by the Public Service Commission of New York, the Commissioners state:

"We have nothing before us but the suggestion that the Dominion of Canada may at some future time forbid this exportation. This Commission must assume that international relations affecting so important a subject as the means of continuing great industries which have grown up in reliance upon the use of this imported power, and as well the interests of the Canadian producing companies themselves have become fixed and subject only to such changes as will fully protect the great commercial and industrial interests and rights now served by this power brought from Canada. The time has long since passed when governments proceed ruthlessly from pure national rashness or anger to destroy the settled accepted commercial relations and formally vested rights of persons and corporations."

Elsewhere the Commissioners also state that "in deciding these cases the Commission must assume that relations between Canada and the United States affecting the means of continuing great industries which have grown up in reliance upon the use of electric power imported from Canada, and as well the interests of the Canadian electric producing companies themselves, have become fixed and subject only to such changes as will protect the great commercial and industrial interests and rights now served by electric power brought from Canada; and particularly so as in these cases it appears that the percentage of export power to plant capacity is the same as has been and is allowed by Canada to other exporting electrical companies."

The Burton Act empowered the issuance of revocable permits for the transmission of additional electric power from Canada into the United States, and it may further be emphasized that the Fluid Exportation Act provides that licenses for the export of power from Canada are also revocable. What, then, is the real import of this remarkable statement by the Public Service Commission of the State of New York? It, in effect, proclaims that we, in New York, need not be concerned about permits and licenses, revocable or otherwise; it states plainly that if we can get this electric energy from Canada into the United States, and have it distributed so that our citizens and industries become dependent upon it, then Canada could not hope to alter these conditions, for, in the words of the Commissioners, the conditions in the State would "have become fixed, and subject only to such changes as will protect the great commercial and industrial interests and rights now served by electric power brought from Canada, that is to say, as will protect "the great commercial and industrial interests and rights" in the United States.

Some years ago, when the relations of the United States with Canada were under discussion before the "Select Committee on Relations with Canada, of the United States Senate," Mr. Joseph Nimmo, Jr., addressed the committee with respect to the possibility of Canada dealing with her transportation facilities in a manner such as, adversely, to affect interests in the United States using Canadian transportation, and stated that "in the entire range of our Canadian relationship, from Halifax to Vancouver, the United States holds an overpowering advantage over Canada, and at every point. The suspension of the transit trade would be of comparatively small disadvantage to the United States, whereas it would be utterly disastrous to Canada. . . . It is high time for the people of this country to appreciate the fact that their National Government holds a preponderance of commercial power on this continent as absolute as the preponderance of its military power, and to demand that those who are charged with the affairs of government shall adopt such measures as shall prevent any interference by a foreign power with the course of the development of our domestic or foreign commerce."

Canada, in connection with the exportation of electricity, certainly does not desire to assist in the creating of any circumstances which would even tend to invite a possible carrying out of any such policy as is suggested by the language in the Opinion delivered by the Public Commission of the State of New York, or in the address, just quoted, as delivered at Washington before the Select Senate Committee on Relations with Canada.

When the diverse and powerful financial interests which are represented in these great Niagara developments are scrutinized, it will demonstrate the absolute necessity that we possess such a knowledge of the facts as will enable wise counsel respecting the adoption of administrative policy respecting the hydro-electric power appertaining to Niagara. To these matters the Commission of Conservation have devoted much study.

Other Water Problems Suggested.—Questions connected with other waters such as with the St. John River in New Brunswick; navigation and power on the St. Lawrence; transportation on the Great Lakes, and via the proposed Georgian Bay Canal; questions relating to diversion and power development on the St. Mary River, Lake Superior; or on the Fraser and the Columbia Rivers in British Columbia; diversions for irrigation of the St. Mary and Milk Rivers in Alberta; power or other problems involving the Pend d'Oreille, the Kootenay, Okanagan, Skagit and other rivers and lakes in British Columbia, are indicative of the many and diverse subjects in which this Commission is interested, and frequently especially interested on account of the international complications which exist, or which may arise in connection with the use, or abuse, of such waters.

DEVELOPMENT OF PARK.

The development of the National Park at Banff, in the Rockies, under the scheme of Mr. Thomas H. Mawson, is progressing. The new concrete swimming pool and bathhouse have been completed. The pool, 150 feet long and 35 feet wide, is built on the side of the Sulphur Mountain, 4,575 feet above sea level. A large spring of sulphur water provides the supply. The bathhouse has provision for 132 bathers.

The last steel for the Transcontinental line of the Canadian Northern Railway has been laid at Basque, a village on the North Thompson River, 200 miles east of Vancouver. The C.N.R. enters British Columbia through the Yellow Head Pass and parallels the Grand Trunk Pacific for many miles.

A special general meeting of the shareholders of the Ontario Power Company is to be held on February 16th at Niagara Falls, to consider the issue of $1,660,000 five-year 6 per cent. second mortgage convertible gold bonds to be secured by a mortgage on the assets and undertakings of the company, this mortgage to secure also two issues of debentures outstanding to an amount of $3,340,000 and to consider also an increase of the capital stock of the company from $10,000,000 to $15,000,000.

ESTABLISHING A WATER METER RATE.

A METER rate should be based upon two factors—the cost of supplying water, and the method of distributing the cost among the consumers. The following table, and its appended explanation for those waterworks having incomplete data or without expert engineering advice, will be found of assistance in arriving at the cost of supplying water. It is essential, of course, that the figures and estimates for each item cover the same period, preferably the last previous year.

Elements of a Meter Rate.

1. Fixed Expenses.
   - Interest on bonded debt ....
   - Sinking fund to retire bonds ....
   - Depreciation ....
   - Franchise dues ....
   - Insurance ....
   - Taxes ....
   - Other fixed expenses ....
2. New Equipment Expenses.
   - Pipe, hydrants, valves, meters, etc. ....
3. Operating Expenses.
   - Labor—Executive, clerical, engineering, legal, manual, inspecting, etc. ....
   - Supplies—Fuel, oil, stationery, etc. ....
   - Tools ....
   - Purification ....
   - Business promotion ....
   - Contingent expenses ....
   - Other operating expenses ....
4. Profit Desired ....
5. Sources of Revenue Exclusive of Water Sold.
   - City appropriations from general fund ....
   - Hydrant rentals ....
   - Private fire services ....
   - Automatic sprinkler connections ....
   - Construction of new services ....
   - Extension of mains ....
   - Fees for shutting off and turning on water ....
   - Other sources ....
6. Annual Quantity of Water Pumped ....
7. Percentages of Water Non-productive or Unaccounted For.
   - Public uses—Fountains, buildings, parks, etc. ....
   - Fighting fires ....
   - Flushing mains ....
   - Self-consumed ....
   - Furnished on bad accounts ....
   - Slippage in pumps ....
   - Slippage in meters ....
   - Leaks in Mains ....
   - Other causes ....

The following explanation of the table may be of value:—

Fixed expenses include all expenses not affected by the volume of business, and generally vary only slightly from year to year. Among these, depreciation is the only uncertainty and is governed entirely by local conditions. Some waterworks set aside annually for depreciation two per cent. of the cost of the plant exclusive of real estate—this estimate is close enough for practical purposes. Where provision is made for a sinking fund, of course depreciation is not considered.

New equipment expenses are intended to cover those minor permanent additions to the plant which are paid for from current revenues every year.

Operating expenses vary, depending upon the volume of business being done. For new plants the construction engineer can estimate these costs closely enough. Contingent expenses cover breaks in mains, personal injury suits, etc.—ten per cent. of all other operating expenses is a liberal estimate for this purpose.

Profit. This element enters into the rate of the privately owned waterworks only. Since the supervision of public utilities is recognized as a government duty it may be well to cite that the Wisconsin R.R. Commission usually allows about seven per cent. on the fair value of a waterworks property and business for the annual interest and profit.

Sources of revenue exclusive of water sold deserves careful study as it introduces the question of what proportion of the expenses fire protection should pay. Where laws do not permit a municipal waterworks to charge for fire protection or other water service the cost must be paid by increasing the charge to the private consumers. This is not fair, as some premises receiving fire protection may not be water consumers, and others having much property use very little water. Hydrant rentals or fire protection costs should be paid out of the general tax levy, because the benefit of fire protection to the taxpayers is about in proportion to taxable value of property.

Good authorities on the subject recommend the following as one way of determining fire protection charges: (1) Estimate the cost of constructing a waterworks sufficient for fire protection only. (2) Estimate the cost of constructing a waterworks sufficient for all purposes except fire protection. (3) Add 1 and 2 and the proportion each is of the total is the proportion of the "fixed expenses" and "new equipment expenses" (see table) chargeable to each. (4) Estimate the "operating expenses" including "profit" necessary to maintain fire protection. (5) Estimate the "operating expenses" including "profit" necessary to supply all other uses. (6) Add 4 and 5 and the proportion each is of the total is the proportion of "operating expenses" and "profit" chargeable to each. These calculations will usually show from twenty-five per cent. to sixty per cent. of "fixed expenses," "new equipment expenses," "operating expenses" and "profit" chargeable to fire protection. As a rule, the larger the plant the lower the percentage of fire protection cost.

Annual quantity of water pumped may be determined by station meters or estimated from displacement of pump plungers. On fully metered plants the daily consumption runs from 40 to 120 U.S. gallons per capita, depending upon local conditions; the average is about 75 U.S. gallons per day.

Percentage of water non-productive or unaccounted for. A study of the items under this heading reveals that from five per cent. to fifty per cent. of water supplied by waterworks produces no revenue. In case reliable data or estimates of these items are not available a waterworks may consider that with no free services it may receive pay for seventy-five per cent. of water supplied and sixty-five per cent. if there is free public use.

It is customary to establish the price for metered water per 1,000 gallons, or per 100 cu. ft. There is a difference of opinion as to which is preferable, but since the gallon is the universal unit of liquid measurement in this country there is no reason for using a special unit such as the cubic foot when selling water. The average consumer has a more definite idea of what he is getting when the bill reads 1,000 gallons than if it reads 133 cu. ft. It is certainly a good policy to have the meter rate and the meter dial in the same unit of measurement.

The above table and its explanation have been sent us by the Buffalo Meter Company, who offer to act in an advisory capacity concerning the most suitable meter rate, to any waterworks man who inquires, and at the same time supplies the information for which the chart calls.

RAIL CREEPING.

SOME of the causes of rail creeping are given as follows by Mr. J. J. Bethune, roadmaster, I.C.R., Charlottetown, P.E.I., in a recent issue of the Canadian Government Railway Employees Magazine: (1) The effect of gravity, from the top of the grade to a sag, together with the application of the brakes to the wheels on the down grade, is the first or aggressive cause. (2) Track laid without the proper spaces left at end of rails for expansion, this causing rails to creep in the direction of least resistance, if there were no trains running on it. (3) Track not properly buried in ballast to prevent ties moving sideways. (4) Spikes not driven down tight in contact with rail flange. (5) Slot spikes at joints getting worn out, and in some cases breaking off. (6) Joint bolts not kept perfectly tight. With the exception of the first cause these can, by close attention, be, to a certain extent, remedied.

In order to prevent rail creeping, or at least reduce it to a minimum, track must be well ballasted and filled within one inch of top of tie, with good heavy gravel or broken stone ballast, tie properly spaced and placed at right angle with rail, spikes at intervals kept driven down with head in contact with rail flange, slot spikes kept in good condition and in place, track bolts kept tight, and I have found it a good plan where joint ties kept pushing down grade in light ballast to put short struts made of 2 x 3 spruce between ends of ties on the down grade side, for three or four spaces, in order to get the support of the side thrust of three or four more ties to assist joint tie. No doubt the best preventive and final one, with the other conditions I have mentioned being attended to, is to apply a good anti-creeper, of which there are many on the market. I am not in a position to recommend any particular kind, as my experience in the use of them is limited.

But there are some peculiarities about rail creeping that are difficult to solve. I have in mind a piece of track on my own division on a down grade of 1.4 per cent. and curves of 9 degrees. On three miles there is only 3/10 mile of tangent altogether, made up of short tangents between curves. The right and left curvature about balances, track direction being about due east and west. This piece of track has in two years crept 18 in. more on the north rail than on the other. It would be reasonable to think that on a long simple curve that the outside rail would have a greater tendency to creep on account of the continual side friction of the wheels, but in the case I have mentioned, on account of the curves being about balanced, it is natural to conclude that the creeping would be about equal on both sides of the track. I would be pleased to have the opinion of some of your correspondents on this point. The only reason that I can see for this difference is that perhaps the heat of the sun in summer would have a better chance to strike the north rail during mid-day, especially in clay cuttings, where the south rail would be, to a certain extent, sheltered.

ECONOMIC LIMIT OF PAVEMENT REPAIRS.*

By George H. Norton, C.E.,
Deputy Engineer Commissioner, Buffalo, N.Y.

In no line of public improvement is there being spent greater sums of money than in providing roads and pavements. Ten or fifteen years ago there was but little published upon this subject. To-day the technical journals are largely filled with it. Numerous associations have combined experiences, both of success and failure, into standards of plans, specifications, and construction details until the vast sums expended are well conserved by engineering experience and judgment.

However well a roadway may be constructed there must be repairs, and such will increase in extent and expense until a limit is reached where renewals are dictated by considerations of economy. While there may be an interesting possibility of maintaining a roadway in satisfactory service by continued repairs for an indefinite time, such to-day appears a remote contingency.

Comparatively little attention has been given to a true limitation between repairs and renewals although the basic theory has been developed. The theoretical problem involved is a most interesting one from a purely engineering consideration. Were all roadways repaired and renewed from a common source of revenue and under a common supervision and determination this question might reasonably be left to the judgment and knowledge of the engineer. However, main highways are often constructed by the State and repairs demanded of a county or town in which located. City pavements are often repaired at general expense, but a portion or all the cost of reconstruction is assessed locally. Wherever there is a transfer of responsibility or financial obligation, when repairs cease and reconstruction is demanded, this problem will become not only an engineering one but one of most general interest, and the limits placed or recommended by the engineer must be susceptible of explanation to others and of such sound and simple elements as to appeal to the lay judgment. The requirement to be met is that of minimum expense for providing a roadway for an indefinite continuous period of time, or determination of the limit where maintenance by repair exceeds in cost maintenance by renewal. To determine this limitation we must know the cost of repairs year by year and the cost of renewal, which may theoretically be the same as the cost of original construction.

Some hold that sinking fund provisions, etc., should enter into this determination, but a full consideration of the various methods by which funds are provided and the varying values of moneys to the diverse contributers to the expense seem to make this an unnecessary refinement, at least until a general theory is better founded and accepted.

For this discussion we accept the fact that pavement repairs increase with the age of pavement and will further assume that the cost of renewal of wearing surface is equal to the original cost of providing such surface.

Where repairs increase directly as the first power of the age then the economical limit of life is reached when the total cost of repairs equals the cost of the article. When these repairs increase with the square of the age then the limit is reached when repair cost equals one-half that of the article. If the repair rate increases by any uniform rate then a mathematical solution can be reached for minimum cost of providing a continuous surface by repairs or renewal.

Unfortunately, the variations in soil, climate, traffic, and materials plus the ever-present limitations of human judgment make most unlikely any regular curve of increase in repair cost of a single road or pavement. No average result of a number of examples can be truthfully used as a criterion for a single case. The determination must, therefore, be made from the record of the individual pavement although such determination may well be made in the light of a knowledge of general behavior and limitations of other similar construction. The method here proposed is simple in its application, readily understood by the layman, and is apparently as accurate as this problem at its best will warrant.

To determine the economical limit of repairs two variables must be considered and the limit will occur at the minimum of their sum. If a pavement surface is used 20 years, one-twentieth of its cost may be taken as its annual depreciation, but if in use but 10 years then one-tenth the cost is the annual depreciation. For any particular class of pavements there may be prepared a table of depreciation by dividing the cost of renewable surface by numbers representing the age of pavement. For the cost of repairs, if at end of 10 years 10 cents per yard have been expended for repairs, the average rate has been one cent per year. If at 20 years 60 cents per yard have been expended then the average repair rate has been three cents per yard per year.

For an application of this method the following tabulation is made:—

Age N	Annual cost of repairs.	Total cost of repairs.	Average annual cost of repairs.	Annual allowance for renewal.	Annual cost of pavement.
1 to 7	...	3.0	...	....	....
8	2.7	5.7	0.7	18.8	19.5
9	0.8	6.5	0.7	16.7	17.4
10	12.9	19.4	1.9	15.0	16.9
11	4.9	24.3	2.2	13.6	15.8
12	0.6	24.9	2.1	12.5	14.6
13	2.1	27.0	2.1	11.5	13.6
14	2.2	29.2	2.1	10.7	12.8
15	1.4	30.6	2.0	10.0	12.0
16	0.9	31.5	2.0	9.4	11.4
17	2.9	34.4	2.0	8.8	10.8
18	3.0	37.4	2.1	8.3	10.4
19	0.3	37.7	2.0	7.9	9.9
20	3.1	40.8	2.0	7.5	9.5
21	5.8	46.6	2.2	7.1	9.3
22	3.5	50.1	2.3	6.8	9.1
23	9.6	59.7	2.6	6.5	9.1
24	5.9	65.6	2.7	6.3	9.0
25	4.2	69.8	2.8	6.0	8.8
26	...	69.8	2.7	5.8	8.5
27	8.3	78.1	2.9	5.6	8.5
28	12.5	90.6	3.2	5.4	8.6
29	6.9	97.5	3.4	5.2	8.6
30	5.0	102.5	3.4	5.0	8.4
31	5.2	107.7	3.5	4.8	8.3

In the above tabulation the cost of renewable surface is assumed at $1.50 per square yard. This amount is divided by the consecutive numbers representing age of pavement (Col. 1) and gives the annual allowance for depreciation as shown in Col. 5. The actual expenditures made annually for repairs per square yard are given in Col. 2. In Col. 3 is shown the totals of such repair cost

*From The Cornell Civil Engineer.

to the given year and in Col. 4 the average cost of repairs per year to that date (Col. 3 divided by Col. 1). Col. 6 (the sums of Cols. 4 and 5) shows the cost of depreciation plus cost of repairs and in this is to be found the minimum or limit of repairs. This example shows that the cost of providing the pavement over a term of years, depreciation plus repairs, had been a decreasing one excepting in the 28th year where a large repair expenditure had raised the annual cost, but that a lower cost was thereafter reached.

An immediate use of such a tabulation is found in determination of the allowable repairs for any year. An inspection at once shows, with an annual cost of 9.5 cents per yard per year at the 20th year, that if 9.5 cents be expended in the 21st year the annual cost rate will remain the same. As the repairs in the 21st year were less than 9.5 cents (5.8 cents) the average annual cost was reduced to 9.3 cents. Had it exceeded 9.5 cents the average annual cost would have been increased. From the above considerations the following rule is formulated:

The allowable repairs for a succeeding year should not exceed the sum of the total cost of repairs to date, plus the cost of the wearing surface, divided by the age of pavement, and when the necessary repairs will exceed such amount the street should be resurfaced. This rule, like the celebrated artist's paints, should be applied with brains. It is believed to be sound, simple, easy of application, and a valuable aid to an engineer's broad judgment.

SOUND STEEL INGOTS AND CASTINGS.

A new process for making sound steel ingots or castings has been patented by Mr. L. B. Lindemuth, of Steelton, Pennsylvania. It consists in placing on top of the ingot or casting, after it has been poured, a combustible in the form of a metalloid which has a high heat of combustion, and which, when oxidized by an oxidizing blast, will not enter into the steel nor change its composition. The substances recommended are silicon as ferro-silicon (50 per cent.), titanium as ferro-titanium, or aluminium, any one of which is prone to form slag rather than to combine with the metal or dissolve in it, except to a very limited extent. It is claimed that under the most unfavorable conditions these substances will enter only about an inch into the surface of the metal that is agitated by the blast. Each has a specific gravity less than that of the molten iron. The heat of combustion maintains the top of the casting molten until after the body has set sufficiently to overcome any tendency to form a pipe. The inventor states that 50 per cent. ferro-silicon has been used with uniform success on a large number of ingots and castings. The ferro-silicon is added from time to time in small lumps to the surface of the metal, which is agitated by an air blast from a ½-in. pipe. About 5 lbs. of ferro-silicon per ton of ingots is required.

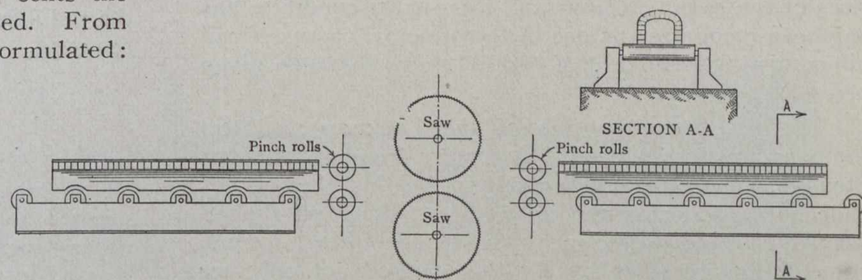
A noted authority recommends that carbon steel should not be forged at a lower heat than about 1,020°F., brown-red heat, as this will produce forging strains. Tools made in such a way are liable to burst, or to become seriously flawed in the centre, or to crack in hardening, especially if not previously annealed.

The electric furnace is being successfully used in the zinc industry, according to "The Engineer." There are works in profitable operation in Norway, Sweden and Finland, while much skilful experimenting has been done in America. In 1913, 4,000 horse-power was being used in producing zinc in Scandinavia, and 7,000 horse-power has been added since then. The firms are very reticent about their methods; in fact, there are no reliable published data about their present type of furnace.

A DESEAMING PROCESS FOR RAIL-SECTIONS.

ONE of the first real improvements of its kind in years is the new method of the Lackawanna Steel Company for improving the quality of its rails.

From the time when railroads began to insist upon harder steel rails to prevent excessive wear, occasioned by the imposition of heavier loads than the softer steel could withstand, one of the principal causes of rail breakage has been what is known to the manufacturers as "seamy bases." Another chief cause of rail failures is "crushed and split heads." The latter are due to excessive segregation producing brittleness in the interior of the section, while broken bases can usually be traced to a bottom seam. It is stated that 50% of the rail problem consists in getting sound metal of even composition, and 40% consists in so rolling steel as to avoid seams in the base.



Sectional View of Machine for Carrying Out Deseaming Operation.

A series of minute seams exists in all steel on all surfaces, but in rails principally in the head and base. The seamy base, however, is the dangerous part of the rail from the fact that seams at this point may, after the rail has seen more or less service, develop into longitudinal cracks, which ultimately lead to complete failure of the rail. Seams in hard steel are a greater menace than in soft steel.

Careful examination has disclosed the existence of seams in the heads and bases of all rails, and, in fact, of all rolled steel. The output of an individual mill may vary, at times approaching nearer the desired state of excellence than at other times, but heretofore the seams have invariably been present.

The attempts that have been made to eliminate this defective condition have been many and varied, but because of a condition inherent in the ordinary process of steel making, and largely beyond the control of the manufacturer, these attempts have not been materially successful. The defects originate while the molten metal is being poured from the ladle into the ingot mould. Air entrapped against the sides of the mould by the rising metal forms small disc-like apertures or flaws on the surface of the ingot. There is also a partially decarburized (and therefore softer) surface about 5/16 of an inch in depth enveloping the ingot on all four sides, and varying from eight to ten points lower in carbon than the metal underneath. This weak, defective, and partially decarburized envelope is undoubtedly produced in the soaking pits, where there is so much oxidation that a thick oxide is always formed on the surface of the ingot.

The development of the surface flaws or holes into seams in the finished rail can readily be explained. Starting as a spot or circular flaw it is gradually changed in the reducing drafts of the rolls until it becomes a finely drawn out line or seam. In this process the partially decarburized surfaces of the ingot become thinner as the reducing drafts elongate the metal, so that in the finished bar this layer varies from .01 to .04 inches in thickness. It is this soft surface that, under the cold-rolling action of the locomotive and car wheels, causes rail heads to slough off and form fins.

The action and direction of stresses in the rail section during service, especially in the rail base, are alternately longitudinal and transverse. So long as they are longitudinal, *i.e.*, in the direction of the seams, the presence of the latter does not materially affect the strength of the rail, but when the stresses are transverse, a rupture often results that follows along the seam, ultimately leading to partial or complete fracture. Thus it is that these surface seams, running as they do in a longitudinal direction, cause failure by weakening the rail-section against cross stresses. It is stated that out of 600 rail failures on one division of a western U.S. road, during 1910 and 1911, 80% were caused by fractures starting from seams in the bases of the rails. At any rate, this seamy condition has long been recognized as one of the principal causes of rail failure, and a great deal of careful study has been given thereto.

The deseaming process of the Lackawanna Steel Company involves a radical departure from all previous attempts, and consists essentially in treating the rail bar while hot and during the rolling, by milling off the respective surfaces sufficiently to secure entire freedom from all surface defects. By this method not only are the seams in the head and base eliminated and the dangers therefrom overcome, but the softer partially decarburized surface is also removed, so that the rolls in subsequent passes do their work on the true, higher carbon steel of the rail bar, and not on the softer defective material which heretofore enveloped it at all stages of its production. This has been accomplished by introducing a machine with a rapidly rotating cutter, at a point where the partially formed rail lends itself readily to the cutting action. This machine has a capacity for handling 170 tons of steel per hour.

The period in the rolling operation which has been decided upon as best for the removal of the defective surfaces is at the time when the hot rail bar is approximately 75 per cent. finished—that is, after the ingot has been bloomed down to an 8-inch by 8-inch cross-section by the blooming rolls, after the end has been cropped and the bloom further reduced by five, more or less, passes on what is known as the roughing or shaping stand of rolls. At this stage the envelope of partially decarburized metal is about 3/32 of an inch in thickness. The machine by which it is removed in the process under consideration subjects the hot rail bar on top and bottom surfaces to cutting action from teeth on two opposed rotating saw discs, just after the hot bar comes down the mill table from the last roughing pass. During this stage of travel a collar roll turns the rail bar so that its head is down and the base up. The bar then enters a tunnel about 20 feet long and lined with fire brick to check heat radiation. It is then forced between the saw discs by a pair of driven pinch rolls, adjustable to bars of various sizes and having guides for the top, bottom and sides of the bar. Adjustment of the saws is made for a cut ⅛ inch or at the extreme 3/16 inch deep. A second set of driven pinch rolls, on the delivery side, helps to force the bar against the cut of the saw teeth and similarly a second set of guides here helps to hold the bar rigidly and firmly during passage through the saw. From the delivery set of pinch rolls the bar travels through about 40 feet more of tunnel similar to that on the entering side and then goes on its way to the stand of finishing rolls. The arrangement is shown diagramatically in the accompanying illustration. The hot bar enters the saw at a speed of about 350 feet per minute, is slowed down by the cutting operation to about 79 feet per minute, and on leaving the saw rapidly picks up speed until it enters the finishing stand at about 500 feet per minute.

The upper saw disc (operating on the base of the bar) has an 8-inch and the lower (operating on the head) a 6-inch face. Both are driven from belted motors, are 5 feet in diameter, have V-shaped teeth of ¾-inch pitch with an allowance of 5 inches for wear and run at a peripheral speed of 25,000 feet per minute, or, in other words, both discs together make 800,000 tooth contacts with the bar per minute.

The rail bars, after passing through the machine, are further reduced in the rolling operation in five, more or less, reducing passes, to a finished section, thereby giving the rail a rolled surface after the defective metal has been removed.

ONTARIO MINERALS, 1914.

During 1914 the mineral production of Ontario decreased slightly, both in respect of precious metals and other minerals. In 1913 the value of the output in Ontario was 9.6 per cent. greater than in the preceding year, the metallic production being $37,508,955, and the non-metallic $15,491,002. The production of gold reached 220,837 ounces, of which more than 94 per cent. came from the Porcupine mines. The output of silver at Cobalt was a little less than in 1912. The high-water mark in production was reached in 1911, when the yield was 31,507,791 fine ounces. Last year's output was 29,681,975 ounces. The price of silver was also lower, the result being to reduce the return to the mining companies by $853,934. It is now ten years since the silver deposits at Cobalt began to be worked, and up to the end of 1913 their total yield had a value of over $98,000,000. The output of nickel was 24,838 tons, valued in the matte at $5,237,477, an increase of a little under 11 per cent. The copper mines produced 12,941 tons, valued at $1,840,942, an increase of 16 per cent.

Returns for the first nine months of 1914 show a reduction in value of shipments of metalliferous ore of some $700,000, the decrease being, however, entirely in silver which fell off $2,885,710 in value of production. Nickel, which is a product valuable at this time on account of its use in making armor plate, shows an increase in the value of shipments of $197,923, the total amount of the output of the mines of the province being $4,023,556. The quantity and value of the various ores shipped is given as follows:—

Gold, 196,934 ounces; value, $3,942,848. Silver, 19,448,018 ounces; $10,082,229. Copper, 11,585 tons; $1,664,986. Nickel, 18,085 tons; $4,023,556. Iron ore, 165,759 tons; $379,918. Pig iron, 495,161 tons; $6,444,213. Cobalt ore, 95 tons; $26,563. Cobalt nickel, 852,014 pounds; $454,687.

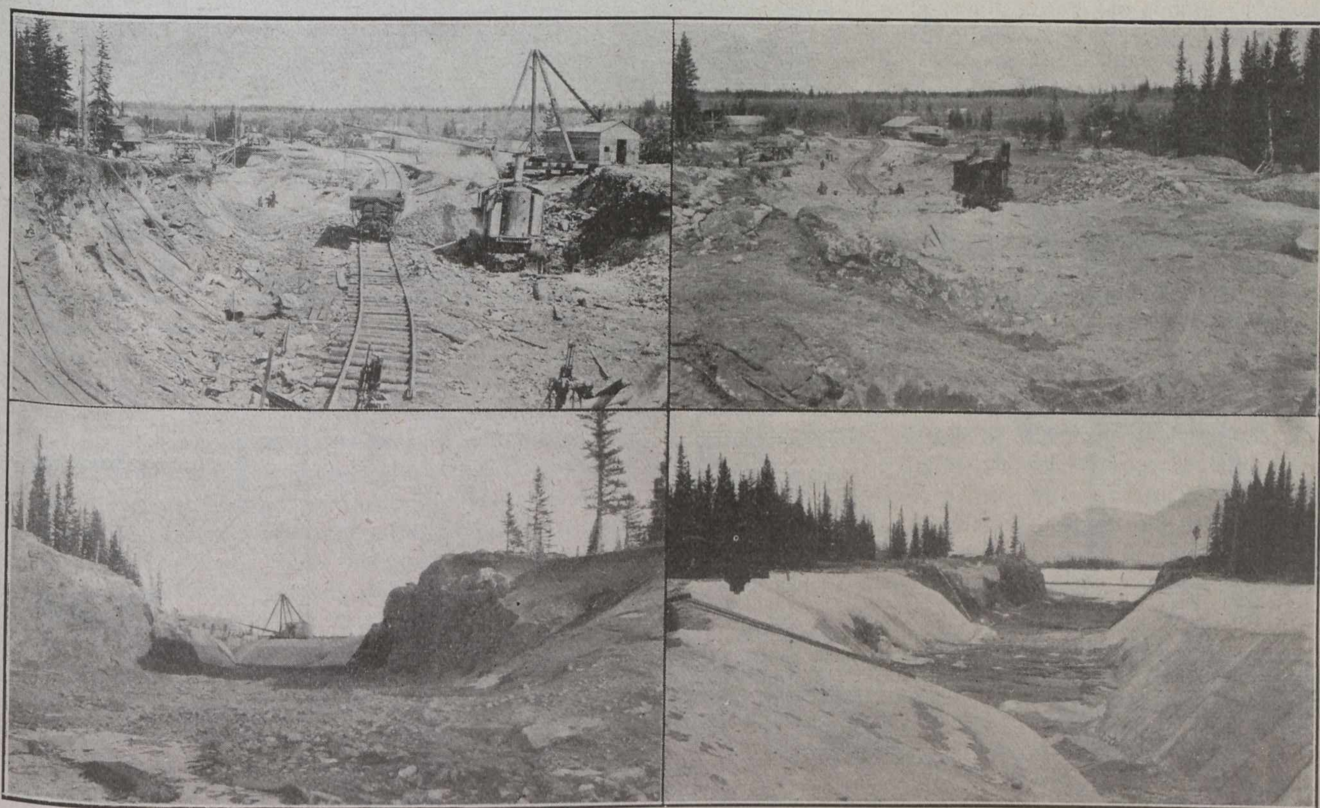
The Sarnia Electric Company is now installing a 1,250 horse-power steam turbine generator and attachments. When the new machinery is completed the power company will have a capacity of 2,500 horsepower, which is quite sufficient for the needs of Sarnia and Point Edward for some years to come.

POWER DEVELOPMENT AT KANANASKIS FALLS.

PART II.

By K. H. Smith, B.A.

IN Part I. of this article an outline was presented of the preliminary investigations, commenced in 1891, of the power possibilities of the Bow River, and of the subsequent development by the Calgary Power Company of the Horseshoe Falls plant. The facilities presented at Kananaskis Falls were also described, stream flow and drainage basin characteristics outlined and the general scheme of development given in brief. The necessary adjuncts attending preliminary operations and the essentials of camp organization were in like manner described. The following deals chiefly with the design and construction of the dam, canal, intake and pressure tubes.



Views of Canal Construction at Kananaskis Falls.

Excavation Looking Towards Headworks. Steam Shovel Excavating Rock.
Headworks Site from Canal Entrance. Completed Canal from Headworks.

It should be stated that the plan of dam construction, as outlined, did not meet with the approval of Mr. Freeman, the consulting engineer. He strongly advocated an arched dam farther down stream, with the power house immediately contiguous to it. In support of his opinion, he presented the following reasons:

(1) Greater factor of safety due to arched structure.

(2) Better operating conditions due to sluices being closer to power house, thereby allowing higher maximum water level.

(3) Economy of initial cost and operation.

The company, however, saw fit to adhere to its original plans because:

(1) It believed there would be no saving in first cost, because considerable work had already been done on the upper site, and the reorganization of the construction layout would also involve considerable expense.

(2) It was anxious to have the work completed as quickly as possible. A general change of plant at this time would mean delay, not only in the reorganization of plant, but also in a slackening of the enthusiasm of the construction staff until such time as they became thoroughly familiar with the new scheme.

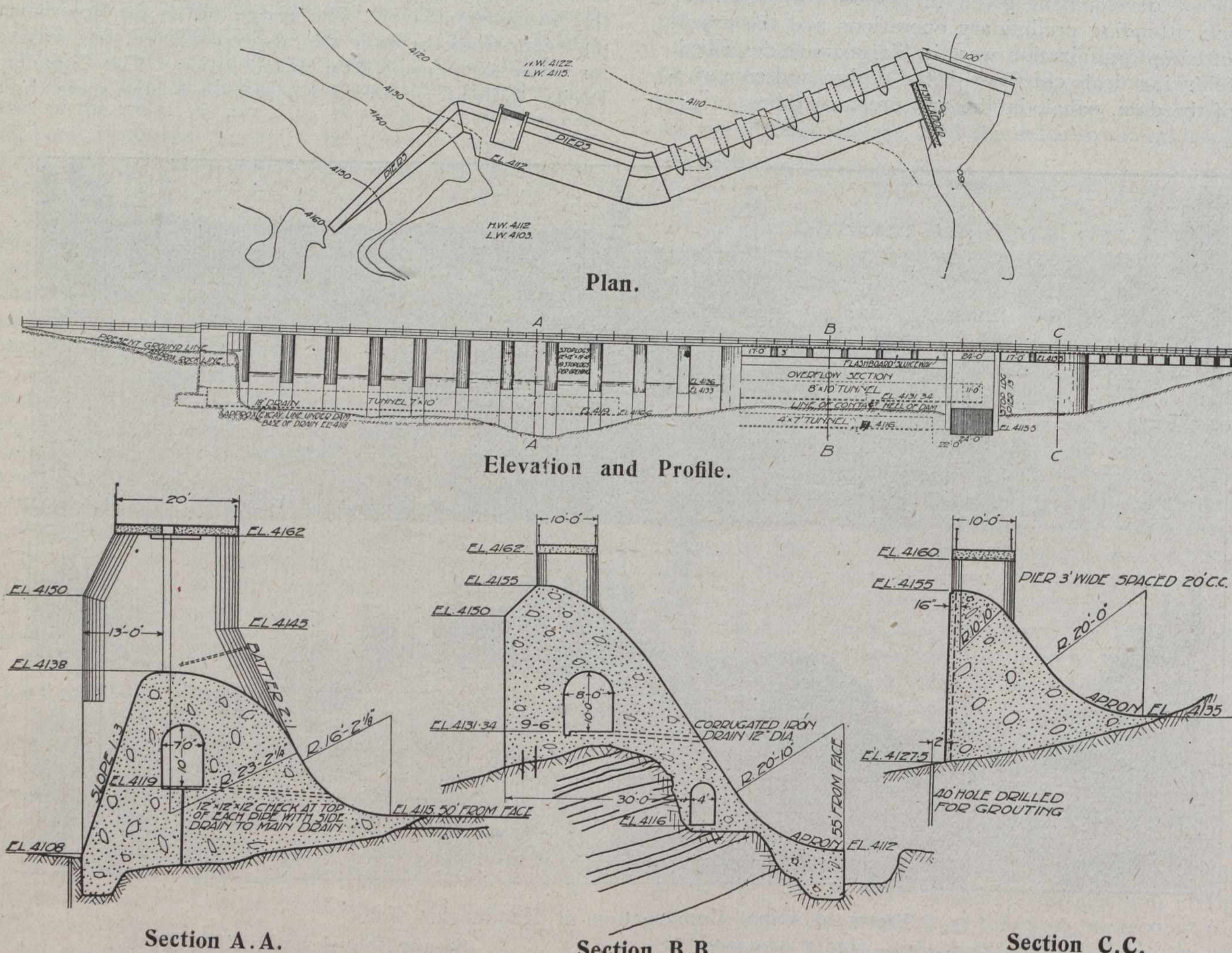
(3) Mr. Freeman was willing to approve their present plans with certain modifications.

The question of maximum head water level was a serious one, and was governed entirely by the elevation of the bottom chord of the Canadian Pacific bridge across the Kananaskis River. The bridge across the Bow River upstream from the dam was also considered, but was so far away as to need little consideration. The Canadian Pacific Railway raised the Kananaskis bridge some three feet at the cost of the Calgary Power Company, and the spillway elevation was fixed at 6 feet below this bottom chord, with the bottom of the deck across the dam 2 feet above contemplated high-water level. These absolute elevations were: Spillway, 4,155; bottom of deck, 4,162. The maximum high-water level contemplated was 4,158, which gave a total discharge with all sluices open of 64,250 feet. The normal head water was then 4,155, normal tailwater 4,085, giving a static head of 70 feet.

Apart from dealing with the question of head-water levels and the general discharging capacity of the dam, Mr. Freeman recommended thorough drilling and grouting of the dam foundations, a complete system of drainage and inspection tunnels with weep drains, and the thickening of the dam above the cliff in the spillway section, since he feared the part of the dam below the cliff might break away from the upper part. His idea was to make the upper part of the section stable in itself.

Details of Dam Construction.—The construction of the dam presented no unusual difficulties, and the placing of concrete proceeded steadily with the plant described in Part I of the article, *viz.*, Insley hoists and hand push-cars on narrow-gauge track. Besides the unwatering operations the only other difficulty encountered was in the final closing of the small temporary sluiceway. This was complicated by the fact that the water could not be entirely shut off, but enough must be allowed to pass to supply the existing Horseshoe Falls plant downstream.

A particularly interesting feature of the construction of the dam was the drilling and the grouting operations. Holes were drilled to an average depth of 40 feet along the upstream face of the dam, about 2 feet from it, and 10 feet apart. The drilling was done by a Calyx core-drill electrically driven, using a soft bit and chilled shot. Two shifts a day were employed most of the time, and the average amount of drilling was about 170 lineal feet per two weeks' period. These holes were afterwards grouted to refusal under a pressure of about 70 pounds per square inch, running as high in one case as 100 pounds per square inch. A single tank designed on the ground was used for this purpose.



Design of Kananaskis Dam.

With this idea in view, an attempt was made to raise the water slowly by placing a few stop-logs at a time. Unfortunately, however, cold weather conditions set in, ice formed under and between the few bottom stop-logs, thereby raising them and rendering it impossible to make the opening tight. These logs were finally abandoned, and a new set placed in a second gain which fortunately had been provided. A low level sluicegate intended to be placed in this opening was also abandoned. The main mixing plant was by this time dismantled due to the rising of the water, and a small mixer was placed on the deck of the dam, from which concrete was deposited behind the stop-logs in the temporary sluiceway, the water in the meantime passing through the permanent sluiceway of the dam.

The complete apparatus consisted of a simple boiler-plate tank, with connections to the air line and to the hole to be grouted; a gauge was also attached. The grouting materials were dumped in through a door in the top opening inward, and therefore requiring no fastening. Mixing was done in the tank itself by turning on the air slightly.

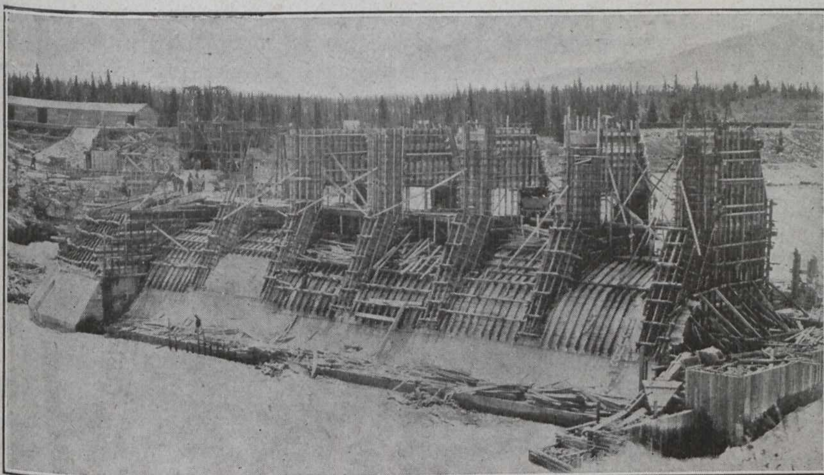
Reference has already briefly been made to the general layout of the dam, which is shown herewith in plan and section. It will be seen that the whole dam is surmounted by a deck with its underside at elevation 4,162, and may be divided into the following main sections:

(1) A stop-log sluice section consisting of eleven openings each 18 feet wide with rollway at elevation 4,138.

(2) A central spillway section with spillway at elevation 4,155, comprising 8 openings each 17 feet wide, and

one log chute opening 24 feet wide. This section was intended originally to have a low level sluice tunnel with centre line at elevation 4,121.5, but this was later abandoned.

(3) A spillway section with spillway at elevation 4,155 comprising 9 openings each 17 feet wide. In all, there are 313 feet free spillway at elevation 4,155, and 198 feet stop-log sluiceway with rollway at elevation 4,138, giving an automatic discharging capacity of about 5,400 second-feet, and a total capacity, exclusive of the discharge through the turbines, of 65,000 second-feet below elevation 4,158. The Department of the Interior required that a total discharging capacity of 40,000 second-feet be provided below elevation 4,158. An electrically operated winch has been installed to handle the stop-logs in the large sluiceway.

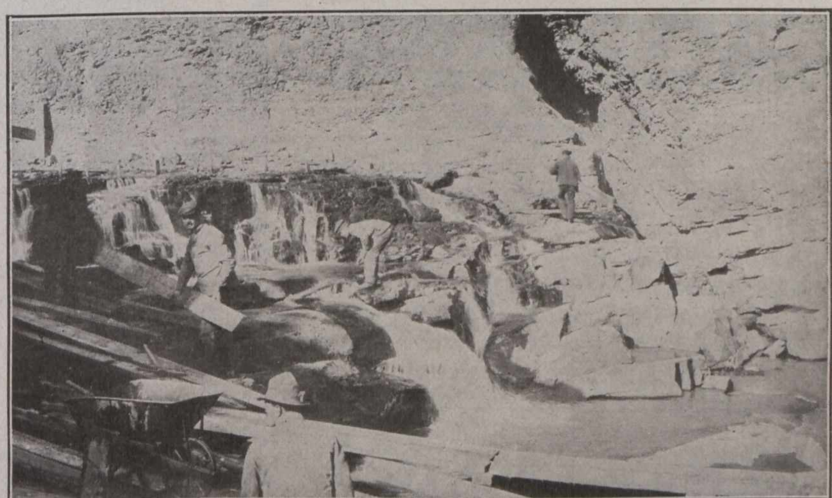


Sluiceway Section of Dam Under Construction.

The dam is provided with a thorough system of drainage and inspection tunnels, while the foundations were thoroughly grouted both from the up-stream face of the dam and from within the tunnels; a number of weep holes extend some 40 feet into the foundations, opening into the drainage tunnels. In the central spillway section, two tunnels are provided, one at the foot of the cliff on which this portion of the dam stands, and the other on top of the cliff. From the lower tunnel, open drains extend to the face of this cliff to take care of any leakage through it, while from the upper tunnel, openings extend well up into the concrete. It was also originally intended to extend a drift into the north bank of the river through the abutment; but this was abandoned and the vicinity of this abutment was thoroughly grouted. The need for this thorough system of grouting and drainage was conclusively shown, not only by the amount of material used in grouting, but also by the appearance of the grout under pressure at various places remote from the hole to which pressure was being applied; notably at the down-stream side of the cliff under the central spillway section of the dam. The efficiency and thoroughness of this grouting is apparent from the fact that on December 31, 1913, it was estimated that the total leakage through the dam from all sources was about 50 gallons per minute, with some grouting from within the tunnel still to be done. This also included one considerable spring encountered near the angle between the two spillway sections of the dam, and deliberately piped out to the down-stream side, the flow from which itself amounted to about 20 gallons per minute. In fact it is expected that when all grouting operations are completed, the leakage from the foundations and abutments of the dam will be practically negligible.

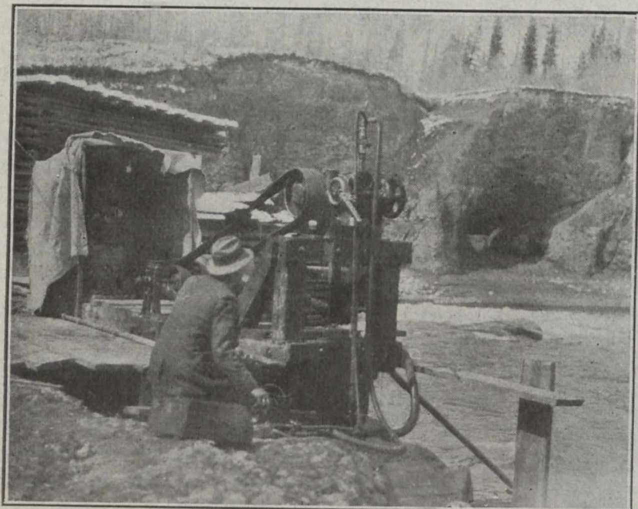
The dam has a maximum height of about 60 feet, and contains about 22,000 cubic yards of concrete.

Canal Construction.—The open canal leading from the forebay to the intake has its bottom elevation at 4,140, averages 18 feet deep and 80 feet wide at the top, and is about 650 feet in length. Its construction involved the removal of 13,865 cubic yards of earth, 17,685 cubic yards of rock, total 31,550 cubic yards; 2,300 cubic yards of back-fill, and 2,340 square yards of "rip-rap" plastered with concrete. Excavation was opened up in the early stages of construction at the entrance to the canal, in order to obtain rock for the main coffer-dam. This was all handled in hand dump-cars; later on, however, excavation was carried on night and day. A travelling derrick with clam-shell bucket was used for a time, and horses with wheel scrapers were used to clean off the surface earth in places. The best progress, however, was made with a small tractor steam-shovel loading into standard-gauge 6 and 12-yard dump-cars, which were handled over the service tracks and dumped in the vicinity of the Kananaskis trestle. Much of the rock was so soft as to be handled by the steam shovel without blasting, while in other places comparatively little drilling and blasting was necessary. The rock in the upper end of the canal was, however, extremely hard. During one period of 8 hours, 45 minutes, seventy-one 12-yard cars were loaded by the steam shovel; most of this was rock which had been loosened by blasting.



Natural Pitch, Showing Nature of Rock at Dam Site.

Several methods were tried in protecting the earth banks of this canal; placing concrete in forms, "rip-rapping" and plastering by means of the grouting tank used for grouting the dam foundation, "rip-rapping" and hand plastering. The last method was finally adopted for most of the work. The banks were trimmed to a slope of 1 to 1 up to elevation 4,152, while above that the slope to elevation 4,158 was 2 to 1, the water level being 4,155.



Calyx Core Drill in Operation.

This flat slope at the top was intended to minimize disintegration of the concrete by ice action. Wet concrete 1 to 5 mix was dumped from barrows down over the "rip-rapped" slope, penetrating and filling most of the spaces. The surface was afterwards finished by hand trowelling. This method was found to be cheap and fast, and so far seems to be quite satisfactory.

Intake and Pressure Tubes.—The general arrangement of the intake and power house was shown in Fig. 4, page 262 of *The Canadian Engineer* for August 6, 1914.

Pressure tubes excavated in rock, and lined with concrete, lead from the canal to the scroll case of each of the two units. The entrance to each pressure tube is through two bays formed by concrete walls. At the entrance to the bays are the usual screens, except that in this case, to aid in overcoming winter conditions, wooden screens are used at and above the water line. There are also stop-log gates for emergency use, though the main control is by large Tainter gates, four in all. These gates consist of steel trusses with wooden lagging. On the bottom is a wooden foot block which comes into contact with two steel knife edges placed in the sill of the intake, thus making a tight joint at the bottom, while leather strips attached to the edges of the gates and projecting into the grooves in which the gates run, make the gates completely watertight. They are operated by hand winches attached to the gates by tackle and so far have given complete satisfaction.

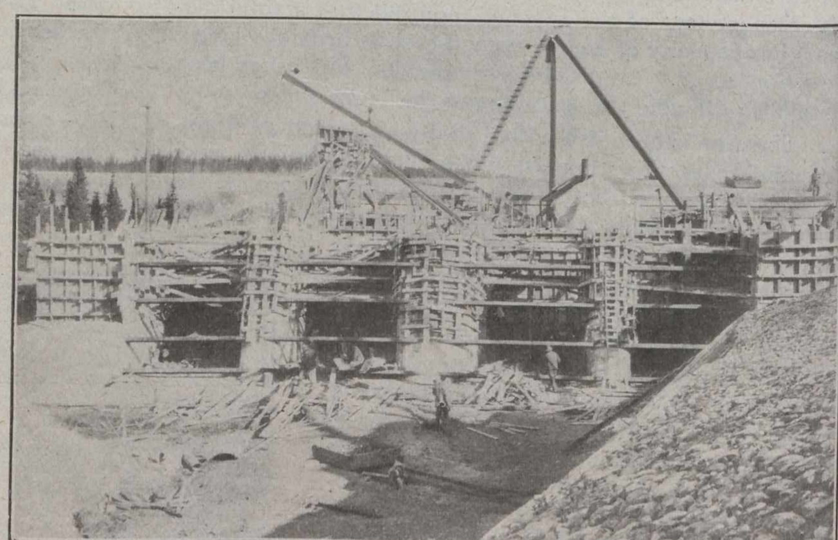
The whole intake structure is enclosed by a structure built of hollow brick, and plastered with concrete.

The pressure tubes are 12 feet by 12 feet at the scroll cases enlarging to 13 feet by 35 feet at the intake. There was considerable overbreak in excavating for them, and to support the heavy mass of concrete on their upper surfaces, a heavily reinforced pillar of elliptical section was placed in the throats of each. Openings were left in the concrete lining, too, through which the surrounding rock was grouted under pressure.

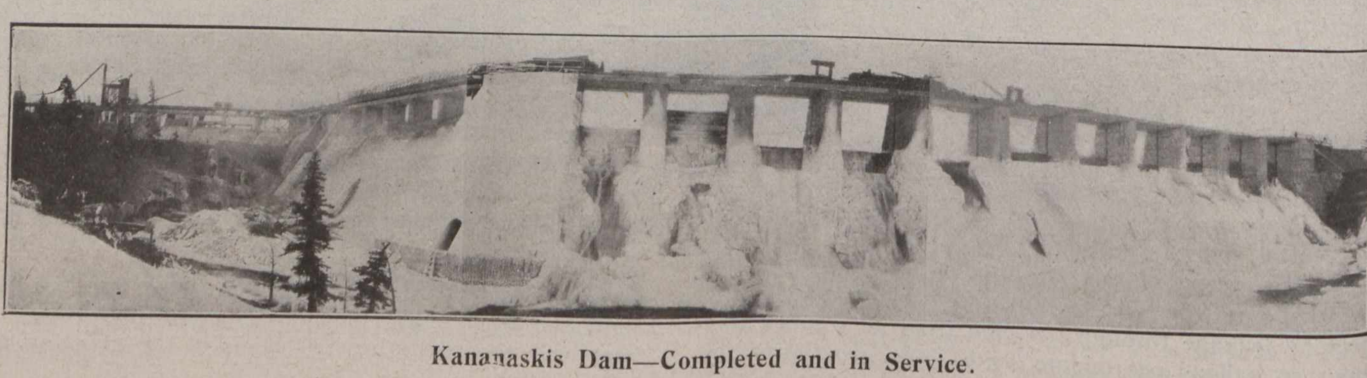
The main quantities in the headworks structure are:

Excavation	2,400 cubic yards earth.
Excavation	550 cubic yards rock.
Backfill	250 cubic yards.
Concrete	1,887 cubic yards.
Brickwork	4,117 hollow tile, 5,000 brick.

[This is the second of a series of three articles on the complete scheme of development. The third article will deal with power house construction and equipment, tail-race tunnels, and considerations of special interest.—EDITOR.]



Headworks Under Construction, Showing Also the Riprapping of Canal Bank Before Surfacing With Concrete.



Kananaskis Dam—Completed and in Service.

Editorial

SNOW LOADS ON SKATING RINKS.

A snowstorm on the morning of January 25th caused the collapse of three skating rinks in the province of Ontario, all within a comparatively short distance of Toronto. A rink at Port Colborne, another erected only last season at Burlington, and a third, that of the Ontario Agricultural College, at Guelph—in each instance the roof fell in as the result of an overload of snow. Had the failures occurred during an afternoon or evening they might have been the cause of serious loss of life. Luckily, they were early morning events.

A snow load on a roof varies with the climate, the slope of roof and the roughness of the roof surface. It may act on one side only, or unevenly on both; the nature of the storm, the intensity of sun's rays, and heavy winds being factors that materially effect the loading. Further, combinations of wind and snow loads frequently occur, although a combination of maxima would be something quite unusual as the heavy wind would dislodge the snow from such a high and smooth resting place. Thus, the load on a rink structure involves a partial snow load, a partial wind load or a combination of both, in addition to the dead weight of the roof itself. Those having to do with the design of buildings in Canada are cognizant of the provision that is to be made in these respects.

Rink structures are perhaps in the category of unusual designs. Further, it may be that inadequate workmanship during construction had something to do with the above failures. Thus two important requirements become involved, *viz.*, competent engineering design and competent engineering inspection. Proper provision against failure is dependent upon both. The former calls for the skill of a structural engineer to ensure safe loading, the latter for the assurance that his plans and specifications are carried out. The use of buildings such as those concerning which reference is being made, should not be permitted unless the design and construction have met with the approval of a qualified structural engineer. Buildings that cannot withstand an extra heavy fall of snow are a menace to life, and when they are public buildings it is a particularly serious matter.

PREPARE NOW FOR BUSY TIMES.

Owing to the phenomenally rapid growth of Canadian cities and towns there are many details which, by virtue of the development they have experienced, have been necessarily overlooked. We refer to works that may hardly be called urgent, and yet that cannot be considered unimportant. Now is a more suitable time than any period in recent years for the cleaning up of odds and ends and the proper recording of completed and projected work in a municipality.

On another page reference is made to an underground survey of the city of Ottawa. Here is one feature that has been sadly overlooked by our cities and towns. Very little attention has been paid to recording the underground location of water and gas mains, etc. It has resulted in numerous financial losses throughout Canada, many of which may be accounted for in the following way: A city decides to undertake, for example, the redistribution of water mains. Very properly, a consulting engineer is called in to advise the municipal authorities on the scheme. One of the first requisites is a partial underground survey of existing mains. The information is needed in a hurry, and such a survey is frequently such a hasty one as to be so inaccurate that it is not only misleading and a cause of delay, but a cause of considerable expense. If proper records had been on file a saving of considerable time would have been effected and the cost of the project reduced.

Owing to the small amount of construction work, many municipalities have discharged their engineers during the past few months. The casualties are pretty well distributed over the entire Dominion, but are so frequent, and the procedure so epidemic in nature, that it is becoming no disgrace for a municipal engineer to entertain thoughts of engaging in some other field of work. A most regrettable feature of the situation is that there is plenty of work for the municipal engineer to do, but it is unlike that upon which he has been for years engaged, in that it does not involve the expenditure of large sums of money. City councils have formed the habit of basing the value to them of their engineering department upon the annual expenditures incurred by that department upon new undertakings, such as waterworks, sewerage systems, paving, etc. Now that there is a lull, existing works are expected to run themselves in many instances.

Instead of dispensing with engineering services, now that money is lacking for a continuation of development, how much better it would be, for instance, to follow the procedure of Ottawa in taking advantage of the slack period to establish an underground survey. It will be found most useful sometime in the future, and there is little doubt that it will save an amount of money many times as large as the expenditure which it will involve.

INTERNATIONAL JOINT COMMISSION.

The International Joint Commission of Canada and the United States had a private conference in Toronto last week. The sessions were largely devoted to an analysis of the data that has been gathered by the Commission's engineers respecting the pollution of boundary waters, and the formulating of a preliminary draft for a set of general recommendations to the governments of both countries. It is hoped that the official report of the evidences of pollution in boundary rivers and lakes will lead to restrictive legislation at an early date.

The personnel of the Commission is as follows: For the United States, Hon. Jas. A. Tawney, of Minnesota, chairman; Senator Obadiah Gardner; Governor R. B. Glenn, of North Carolina, and Whithead Kluttz, secretary. For Canada, Chas. A. Magrath, chairman; Henry A. Powell, K.C., R. B. Mignault, K.C., and Lawrence J. Burpee, secretary.

WATERWORKS EXTENSIONS IN SOUTH VANCOUVER.

Mr. S. B. BENNETT, municipal engineer to the Corporation of the District of South Vancouver, B.C., sends us the following information respecting the waterworks system of that municipality and additions made to it during 1914:—

The water supplied to the distribution system at the present time is through three sources:

(1) From the Capilano and Seymour Creeks, inexhaustible through the public water system of the City of Vancouver.

(2) From wells located in the westerly part of South Vancouver, about one mile distant. These wells are the property of the C.P.R., with whom there is a verbal agreement for the free use of the same by the municipality. The wells vary in depth from 14 to 90 feet, and have a combined flow of approximately 600,000 gallons per day. They are operated by pumps, driven by electric power.

(3) From the Seymour Creek, inexhaustible supply through the public water system of the municipality of Burnaby. There are at present two connections between Burnaby and South Vancouver, but this supply will shortly be abandoned, owing to the new agreement now ratified between the City of Vancouver and the municipality.

The chief construction work undertaken during the past year is as follows:

(1) Laying of 13,895 feet of 8-inch steel main on Main St., from 16 to 58th Ave., together with hydrants and services. Two thousand five hundred and forty-five feet of the above was laid in December, 1913.

(2) Laying of 3,054 feet of 12-inch steel main on Bodwell Rd., from Main St. to Fraser St.

(3) Laying of 5,138 feet of 12-inch steel main on Victoria Rd., from Kingsway to 43rd Ave.

(4) Construction of a steel tank at Central Park, capable of holding 750,000 gallons, together with automatic valve and connections to same, at a cost of $26,148.80.

The wells at the Municipal Hall have been closed, and the pumping machinery dismantled. There are two wooden tanks at the hall, having a storage capacity of 175,000 gallons. These are supplied from the C.P.R. wells, and can also be filled from the Central Park tanks and the City of Vancouver system, by gravity.

In the Central Park district (which is the highest point in the municipality, being 486 feet above sea level) two tanks are provided. The larger one of steel on a concrete base, is 75 feet in height and 45 feet in diameter, capable of holding 750,000 gallons. The other storage tank is of wood, elevated on a wooden trestle, about 45 feet in height, and is capable of holding 100,000 gallons. The water to the tanks at this point is forced up to the high level from a 6-inch main on Kingsway. Up to September last year the only method of filling these tanks was by a 6-inch electrically driven pump, capable of discharging nearly 9,000 gallons per hour. This was inadequate; therefore a 12-inch pump has now been installed, capable of delivering 1,000,000 gallons per day. The total capacity of the tanks is, therefore, 1,025,000 gallons, or rather more than one day's requirements.

Hydrants.—During the year all hydrants were overhauled, repaired and painted. It was frequently found that the water from the hydrants was of a very dark color and brackish nature. There was also a great amount of leakage taking place. The hydrants are now inspected about once every six weeks, the static pressure obtained and report kept of the same. This has produced a very beneficial effect in two ways:

(1) Purer supply of drinking water.

(2) More efficient fire protection.

There are now nearly 700 hydrants in the municipality. Each has a 6-inch barrel, one "steamer" connection and two 2½-inch hose connections. Each hydrant has an independent shut-off. Seventy-five hydrants on the permanently paved streets have a separate gate valve, so that in case of renewal or repair the hydrant can be taken out without interfering with the ordinary domestic water supply.

The hydrants in the main thoroughfares are spaced from about 240 to 500 feet apart, but in the more sparsely populated districts they vary from 275 to 1,000 feet apart.

The following constitute the main particulars of the foregoing construction work:

Pipe Laid.

	Mains			
	12-inch.	8-inch.	6-inch.	4-inch.
Main Street ...	....	10,955 ft.	5,385 ft.	766 ft.
Bodwell Road..	3,054 ft.	104 ft.	209 ft.	345 ft.
Victoria Road..	5,138 ft.	81 ft.	871 ft.	304 ft.

	No. of valves.	No. of hydrants.	No. of services.
Main Street	84	29	567
Bodwell Road	9	5	84
Victoria Road	29	5	186

Total Cost for Mains, Valves, Hydrants and Services.

Main Street	$36,429.61
Bodwell Road	9,722.71
Victoria Road	17,411.43
	$63,563.75

As new construction work is undertaken, the wood mains at present installed in the system are being replaced by steel, of a minimum diameter of six inches, the old system having proved unsatisfactory, necessitating considerable cost through leaks. The whole distribution system is continually being inspected and any leaks or defects promptly made good. In view of the fact that a considerable proportion of water consumed in the municipality is purchased outside the municipality and passes through meters, it is essential that all wastage from leaks be eliminated.

In some instances, owing to the prohibitive cost of making a complete circuit, we have a number of dead ends in the system, which are objectionable, both on account of lack of pressure and accumulation of stagnant water. Wherever possible, however, these are being dispensed with and the mains looped up and circuited.

The following installations necessitated the expenditure of $123,014.63: 12-in. mains, 8,596 ft.; 8-in. mains, 14,042 ft.; 6-in. mains, 12,514 ft.; 4-in. mains, 26,505 ft.; temporary mains, 15,596 ft.; hydrants, 90; services, $18,259.90; meters, $506.39; maintenance for 1914, $5,982.95; operating for 1914, $9,923.95; lowering mains for 1914, $3,100.80. The total length of mains in the city's system is 206 2/5 miles with 673 hydrants, 9,817 services and 209 meters. Of the $123,014.63 expended during 1914, $64,437.45 was for labor, while material cost $58,577.18.

One of the most important features of the work during the past year has been the completion of a water agreement with the City of Vancouver. This now gives the whole district practically an inexhaustible supply. It has been arranged that the city's mains should be tapped at various points.

PERSONAL.

G. C. McKAY, for six years city engineer of Nelson, B.C., is resigning.

GEO. G. McLENNAN, B.A.Sc., is in charge, for the contractors, the Hyland Construction Co., Toronto, of power-house construction at Eugenia Falls for the Hydro-Electric Power Commission.

HARRY BAYNE has been appointed general agent for Canada of the Safety Car Heating and Lighting Company, with headquarters in Montreal. For 12 years Mr. Bayne was Montreal manager for the Canadian Westinghouse Co.

C. J. TOWNSEND, B.A.Sc., Toronto, will in future carry on the business of the engineering and contracting firm of Wilson, Townsend and Saunders, with headquarters at Toronto, Mr. Townsend having taken over the interests of the retiring partners.

R. FRASER ARMSTRONG, B.Sc., has been appointed superintendent of water and sewerage at St. John, New Brunswick. He is a graduate of the University of New Brunswick, and took post-graduate work at McGill University. For several years past he has been engaged at municipal engineering and construction work in the Canadian West.

Professor ERNEST BROWN, M.Sc., M. Eng., is giving an evening course of ten lectures at McGill University, the subject being "Design in Reinforced Concrete." An explanation of principles and their application to typical problems arising in practice forms the basis of Professor Brown's addresses. The course began on February 2nd.

CHAS. J. GOLDMARK, superintending engineer for the Canadian Locomotive Company, Kingston, is severing his connection with the company and will reside in New York. Prior to his departure Mr. Goldmark was tendered a banquet by the company officials, who presented him with a loving cup, turned out in the pattern shop of the locomotive works.

W. G. McINTOSH, B.A.Sc., has recently been appointed sales-engineer for Toronto by the Herbert Morris Crane and Hoist Co., Limited. Mr. McIntosh is an honor graduate in Mechanical engineering of the University of Toronto, and has had considerable office, shop and field experience, having been formerly connected with the Otis-Fensom Elevator Co., the Toronto Power Co., the Canada Foundry Co., and the Dominion Bridge Co.

OBITUARY.

On February 6th Mr. Walter R. Strickland, a noted architect of Toronto, died at Lakefield, Ont., at the age of 74.

The death occurred in Montreal last week of Mr. John Ross, a prominent contractor in Canadian railroading. Mr. Ross was born in Scotland 70 years ago and entered the contracting business in Canada at an early age. He used to be in partnership with the late Duncan McDermott, and it was this firm that built the C.P.R. line through the Rocky Mountains and afterwards did considerable work throughout the north-west for the different railways in the early days. Ten years ago Mr. Ross became affiliated with the Ross, Harris, McRae Contracting Company, which constructed the Toronto-Sudbury branch of the C.P.R. They also handled large contracts for work on the old Welland Canal. This firm also built several sections of railway lines through the Province of Quebec. Recently Mr. Ross had been doing sub-contracting work for the Canadian Northern and Grand Trunk Railways.

CANADIAN FORESTRY ASSOCIATION.

At the recent annual meeting of the Canadian Forestry Association the following executive officers were elected for 1915: President, F. C. Whitman, Annapolis Royal, N.S.; Vice-President, J. B. Miller, Toronto, Ont.; Secretary, James Lawler, Ottawa.

Territorial Vice-Presidents—Ontario, G. H. Ferguson, Toronto; Quebec, Justice Allard, of Quebec; New Brunswick, George J. Clark, St. Stephen, N.B.; Nova Scotia, O. T. Daniels, Bridgetown, N.S.; Manitoba, Sir R. P. Roblin, of Winnipeg; Prince Edward Island, J. A. Matheson, Charlottetown; Saskatchewan, G. W. Brown, Regina; Alberta, A. L. Sifton, Edmonton; British Columbia, W. R. Ross, Fernie; Yukon, Commissioner George Black, Dawson City; Mackenzie, F. D. Wilson, Fort Vermilion, Alta.; Keewatin, D. C. Cameron, Winnipeg, Man.; Ungava, Mgr. Bruchesi, Montreal, Que.

Board of Directors—William Little, Alex. MacLaurin, Hiram Robinson, Aubrey White, E. Stewart, W. B. Snowball, Thomas Southworth, W. C. Edwards, George Y. Chown, John Hendry, W. Charlton, W. J. Roche, George H. Perley, Sydney Fisher, R. H. Campbell, William Power, Gordon C. Edwards, Dr. B. E. Fernow, Ellwood Wilson, Senator Rostock, G. C. Piche, Mgr. Roy A. P. Stevenson, William Pearce, C. E. F. Ussher, Denis Murphy, Clyde Leavitt, Jackson Booth, William Price, J. W. Harkam, A. S. Goodeve, W. C. J. Hall, J. S. Dennis, J. B. White, E. J. Zavitz, George Chahoon, jr., R. D. Prettie, N. Curry, A. C. Flumerfelt, and H. R. MacMillan.

CANADIAN SOCIETY OF CIVIL ENGINEERS.

REGULAR MEETING, MONTREAL, FEBRUARY 4th, 1915.

The chairman, Mr. Walter J. Francis, presided at the regular monthly meeting of the Canadian Society of Civil Engineers, held at headquarters, 176 Mansfield Street, on the evening of the 4th inst. An excellent paper on "Movable Dams," by Mr. H. B. Muckleston, M. Can. Soc. C.E., Calgary, was read by Professor Brown, M. Can. Soc. C.E., of McGill University, in the absence of the author. The reading was illustrated by a number of slides showing typical structures in the various types of movable dams, and the discussion afterwards was joined in by Mr. Arthur Surveyer and others. (For an abstract of the paper, see *The Canadian Engineer*, Feb. 4th, page 217.)

After the reading of Mr. Muckleston's paper, Mr. H. H. Vaughan, M. Can. Soc. C.E., Vice-President of the Canadian Pacific Railway, gave an informal talk on "The Manufacture of Shells in Canadian Shops," illustrating his remarks more particularly by slides made from photographs taken in the shops of Messrs. Bertram and Sons and the Canadian Pacific Railway Angus shops. All the processes in the manufacture of the steel shell cases and the brass cartridge cases were graphically set forth by the speaker. At the conclusion of the address a discussion followed, in which Lieut.-Col. Lacey R. Johnson, M. Can. Soc. C.E., took an important part.

At the conclusion a hearty vote of thanks was tendered to Mr. Muckleston for his paper, to Professor Brown for reading it and providing the slides, and to Mr. Vaughan for his lucid address. The chairman announced that at the next meeting, on the 14th inst., a paper by Mr. A. C. D Blanchard, M. Can. Soc. C.E., describing "The Lethbridge Sewage Disposal Plant" would be read, and that an address on "The Use of the Sixty-Pounders" would be given by Lieut.-Col. Lacey R. Johnson.

MANITOBA GOOD ROADS BOARD.

Hon. Dr. Montague, minister of public works, has announced that a good roads board has been formed to look after road development in the province under the provisions of the Good Roads Act. The board will consist of Highway Commissioner A. McGillivray, chairman, ex-Mayor T. R. Deacon, and C. E. Ivens, of Virden. The secretary will be Ald. Marion, of St. Boniface.

Besides seeing to the carrying out of the provisions of the Good Roads Act, this board will compile statistics and collect information regarding the character and condition of roads, the cost of building and maintaining, and pass upon the best means of the keeping up of the roads. They will be expected to supply any information regarding roads to representatives of the different municipalities, and to promote good roads throughout the province.

PUNTLEDGE RIVER POWER PENSTOCK.

In our description of the Puntledge River Power development (see *The Canadian Engineer*, January 28th, 1915), the penstock line was described as being a 660 ft. "block beam" steel pipe, ⅜ inches thick at the upper end and 7/16 inches thick at the lower end. This should have read "lock bar" steel pipe. In justice to the manufacturers, the Canadian Steel Pipe Co., Limited, we take this opportunity of making the correction.

ONTARIO LAND SURVEYORS' ANNUAL MEETING.

The Association of Ontario Land Surveyors will hold their twenty-third annual meeting at the Engineers' Club, Toronto, on February 16th, 17th and 18th. Mr. J. W. Fitzgerald, O.L.S., Peterborough, Ontario, will preside.

On Tuesday, in addition to the presentation of reports of council, secretary-treasurer, etc., the president's address will be delivered and the following papers presented: "Possessory Titles," by F. N. Rutherford, O.L.S.; "City and Suburbs Plans Act," by T. D. LeMay, O.L.S., and "Reminiscences," by A. L. Russell, O.L.S. Reports will be submitted by Mr. L. V. Rorke, chairman of committee on publication; Thos. Faucett, chairman committee on topographical surveys; L. B. Stewart, chairman committee on exploration, and G. B. Kirkpatrick, chairman board of examiners.

In the evening Mr. J. S. Dobie, O.L.S., will read a paper, entitled "Stone Crushing," and another will be presented by Mr. J. S. Lang, O.L.S., comprising a review on land surveying.

On Wednesday morning, Mr. C. J. Murphy, chairman of the committee on land surveying, will present a report, after which a paper entitled, "Surveys in the Double Front Concessions of the Early Thirties," will be presented by Mr. M. Gavillier, O.L.S.

In the afternoon, the following reports of committees will be presented: On Engineering, Mr. N. D. Wilson; on Drainage, Mr. G. A McCubbin; on Roads and Pavements, Mr. J. S. Dobie; on Repository and Biography, Mr. Willis Chipman.

The annual dinner will be held in the evening at the Engineers' Club.

On Thursday morning reports will be received from committee on legislation, Mr. G. B. Kirkpatrick, chairman, and from the committee on entertainment, Mr. T. B. LeMay, chairman. This will be followed by the nomination and election of officers and the transaction of unfinished business.

COMING MEETINGS.

AMERICAN CONCRETE INSTITUTE.—Eleventh Annual Meeting, to be held in Chicago, February 9th to 12th, 1915. Secretary, Edward E. Krauss, Harrison Building, Philadelphia. Pa.

NATIONAL BRICK MANUFACTURERS' ASSOCIATION.—Annual meeting to be held in Detroit, Mich., February 15th to 20th. Secretary, T. A. Randall, Indianapolis, Ind.

EIGHTH CHICAGO CEMENT SHOW.—To be held in the Coliseum, Chicago, Ill., from February 10th to 17th, 1915. Cement Products Exhibition Co., J. P. Beck, General Manager, 208 La Salle Street, Chicago.

ASSOCIATION OF ONTARIO LAND SURVEYORS.—Twenty-third annual meeting to be held in Toronto, February 16th, 17th and 18th. Secretary-treasurer, L. V. Rorke, Parliament Buildings, Toronto.

CANADIAN MINING INSTITUTE.—Seventeenth annual meeting, to be held in Toronto, March 3rd, 4th and 5th. Secretary, H. Mortimer-Lamb, Ritz-Carlton Hotel, Montreal.

AMERICAN RAILWAY ENGINEERING ASSOCIATION.—Annual meeting to be held in Chicago, March 16th to 18th, 1915. Secretary, E. H. Fritch, 900 South Michigan Avenue, Chicago.

CANADIAN AND INTERNATIONAL GOOD ROADS CONGRESS.—Second Annual Convention, Toronto, March 22 to 26, 1915. Secretary, Geo. A. McNamee, Dominion Good Roads Association, Montreal.

TORONTO ELECTRICAL SHOW.—The second annual exhibition, to be held in the Arena, Toronto, April 12th to 17th. Secretary, Mr. E. M. Wilcox, 62 Temperance Street, Toronto.

AMERICAN WATERWORKS ASSOCIATION. — The 35th annual convention, to be held in Cincinnati, Ohio, May 10th to 14th, 1915. Secretary, J. M. Diven, 47 State Street, Troy, N.Y.

SOCIETY FOR THE PROMOTION OF ENGINEERING EDUCATION.—Annual meeting to be held at the Iowa State College, Ames, Iowa, June 22nd to 25th, 1915. Secretary, F. L. Bishop, University of Pittsburgh, Pittsburgh, Pa.

COAL EXPORTS FROM UNITED STATES.

The United States, which produces 40% of the world's coal, exports annually 27,500,000 tons, or about 5% of the output of last year, the total export in the fiscal year being valued at $86,000,000. Exports of domestic coal have doubled during the last decade, having increased from 8,482,867 long tons in 1904 to 19,664,080 tons in 1914, the latter total being with one exception (1913) the largest on record. In addition to exports consigned to foreign countries, domestic coal laden on vessels engaged in foreign trade for use as fuel amounted in 1914 to 7,811,913 tons and shipments to Hawaii and Porto Rico aggregated 133,501 tons, making total shipments out of mainland ports 27,609,494 with an aggregate valuation of $85,925,001.